THE

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THE

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ELECTRIC POWER SUPPLY FROM CENTRAL STATIONS.

NOTWITHSTANDING the enormous progress that has been made in this country in the last half-century in perfecting and cheapening our methods of production, and of transporting the raw material to, and the finished article from, the manufacturer, we find that other nations have advanced as fast or faster than ourselves, and that our manufacturing supremacy is no longer so marked as in past times. The causes of this increased competition are many and various, and if we wish to maintain our position in the front, we must take care to make the most of such advantages as we possess; employers must not be slow to adopt labour-saving appliances, nor to replace existing tools by others of improved design and greater possible output; the management must keep a sharp look out for, and at once remove, all possible causes of waste; and the workman must realise that his chance of increasing his weekly earnings lies in doing his best to increase the output of the machinery he tends.

We have been accustomed to think that our coal fields and railways give us an advantage over our rivals; but this is not always so, as there are cases where transport freights are lower in other countries than with us, and the introduction of electric transmission of power has made it possible in some districts to do without coal, and to utilise the energy of falling water. The fact that in our manufacturing districts coal is cheap, and that in many cases the cost of power is only a small item of the total cost of production, has made many of our manufacturers somewhat neglectful of this branch of their operations; and we too often see boilers, worked at ridiculously low pressures, supplying steam through long ranges of pipes to small and uneconomical engines, or engines transmitting power through such an amount of shafting, gearing, and belting, as to leave but a small percentage of the power produced available at the machines.

The importance of keeping down the cost of power is beginning to be more fully recognised, and already a certain number of works have electric generating stations whence power is transmitted electrically to motor-driven machinery with a gain in economy over the older methods; and it is now proposed by the Midland Electric Corporation for Power Distribution to go a step further, and to put down a central station for the purpose of electric power supply over an extended area. The paper by Mr. Addenbrooke, "Electric Power Supply from Central Stations," which was read a fortnight ago before the South Staffordshire Institute of Iron and Steel Works' Managers, deals with this question of cost of power; and, after some remarks on the cost of water-power as compared with that of power produced by coal, gives an outline of the Midland Electric Corporation's scheme as an example of the best way of getting the power from the coal to the machinery it is to drive.

The comparison of cost of power obtained from water or coal is disappointing, as the paper gives nothing but general

and somewhat vague expressions of opinion, arriving at the conclusion that the difference in annual cost between water and steam power is practically the cost of coal and stoking or handling it; and that "the whole of this difference can only be debited against the coal power on the assumption that no rent is paid for the water-power, nor any inordinate sums for its conservation and utilisation." The subject is a difficult one, and the paper before us does not add much, if anything, to our knowledge of it; as we cannot consider any arguments of much value which are unsupported by figures of the capital cost of existing water-power installations. Mr. Addenbrooke says that the cost of buildings, dynamos, switch gear, motors and mains, will be the same in both cases, except that, as regards the mains, water-power will generally be at some disadvantage, because large waterfalls are often not very accessible. It appears to us that this point may be of considerable importance, as either the distance that power has to be transmitted will be very much greater, or, if works are erected near the water-power, the cost of transport of material to and from the works will be increased. It must not, however, be forgotten that this very inaccessibility of the water-power often permits of the use of bare overhead wires, and a cheaper line construction than would be possible in South Staffordshire or other districts equally well placed as regards cost of coal.

We are next told that we shall not be far out if we put the cost of turbines, turbine pits, sluice gates, and general arrangements against that of steam engines of similar power, but no figures are given; indeed, the only figure of capital cost given in this part of the paper is that the cost of boiler plant, with condensers and economisers, will be about £4 per horse-power, and we are asked if the necessary canals, tunnels, embankments, weirs, or dams could be constructed for the same figure. But this is just the question we would ask the author of the paper; as, unfortunately, English engineers have little chance of gaining personal experience in such work, although they would have no difficulty in fixing the cost of a boiler plant of any given size. It would, therefore, have been much more satisfactory if Mr. Addenbrooke had been able to tell us the capital cost of various water-power installations, even if he had left us to supply the figures for steam power.

With regard to working expenses and general charges, we are told that whilst the depreciation on buildings, dynamos, switch gear, motors, and mains will be the same in each case, on boilers and engines it will probably be greater than on turbines, canals, and other constructional work, and that the cost of administration, of engineering staff, and of rates, taxes, and other standing charges, will probably be the same. By balancing the greater depreciation on steam plant against the probable greater capital cost of water plant, Mr. Addenbrooke arrives at the conclusion that the cost of coal and stoking is the only unbalanced item, and proceeds to calculate this cost per I.H.P. per annum. The figure arrived at, viz, £2 10s. per I.H.P. for a working year of 8,000 hours, is quite possible of attainment with a good load factor; but if steam-power had to compete against water-power with that extra charge against the former, it would be a serious handicap in an industry where power is used continuously, and where its cost forms a large proportion of the total cost of production. A working year of 8,000 hours is not, however, the normal thing in England, the usual conditions being a 54-hour week, or, say, 2,800 hours per annum, and Mr. Addenbrooke argues that, under these conditions, coal can compete better with water, because the extra charge will be reduced from £2 10s. to 17s. 6d. per annum. This is, of course, true, if the comparison is restricted to one between coal and water, with the same load factor and hours of working; but the statement must not be taken to mean that there is any economy in short hours, as owing to the cost of coal being, in the majority of our manufactures, a comparatively small item in the total cost of production, a steam factory working 10 hours per day may easily produce cheaper than a rival water-power factory, if this latter works only nine hours per day. The load factor is the important item, and we do not think that Mr. Addenbrooke has allowed sufficiently for it in fixing the cost of coal for the smaller number of working hours; as, although the bulk of the demand for power may come between the hours, say, of 6 a.m and 5 p.m., there will always be some demand outside these hours, and the cost of coal per horse-power-hour will undoubtedly be increased by the smaller load factor, and by the stand-by losses.

With regard to the proposals of the Midland Electric Corporation, the paper does not tell us much that has not already been made public, as the system to be employed, whether direct current, two-phase, or three-phase, remains still undecided; but we learn that current will probably be transmitted at 5,000 volts pressure, and some figures are given of the cost of the primary mains. Considerable attention has been given to the method of charging for the electricity, and it has been decided to charge on the Demand meter system, the rates for power supply having been fixed in the agreements with certain local authorities at 3d. per unit for the first hour's use per diem taken on the maximum demand, and ·825d. for each subsequent hour. A table is given in the paper which shows the average price per unit for any number of hours of maximum demand per diem, from which we see that for most manufacturing establishments the average charge per unit would be about 1¼d. At this price it would certainly pay all small power users to take current from the Corporation rather than to generate it with their own plant, but there is no reason why users of 50 horse-power or even less should not be able to generate electricity on their own premises at the same or a lower cost.

Let us consider a case where there are 312 working days of nine hours each per annum, and where the average load is half the maximum. The average charge made by the Midland Electric Corporation would then be 1·3d. per unit., and the charge per kilowatt for the year would be £15 4s. 2d., of which, taking Mr. Addenbrooke's figures, only about 27s. 6d. would represent the cost of coal and stoking at the central station. Of course in an isolated plant the consumption of coal will be much greater, but there should be no difficulty in obtaining boiler, engine, dynamo, and piping for a 50 kilowatt plant at the rate of £25 per kilowatt, and producing the kilowatt-hour for a consumption of 10 lbs. of coal with a load factor of 50 per cent., all stand-by losses included. One man, with occasional extra help for boiler cleaning or other extra work, could look after this plant, and an allowance of £100 per annum for labour will therefore be sufficient. The average output being 25 kilowatts for 2,808 hours, the output in the year will amount to 70,200

units, and the cost of labour will therefore be ·342d. per unit. Taking coal at 5s. per ton, the figure given by Mr. Addenbrooke for the neighbourhood of South Staffordshire, we see that coal will cost $\frac{10 \times 60}{2,240} = ·268$d. per unit, and if we add ·05d. per unit for oil and waste we get for material and labour a cost of ·660d. per unit, leaving a margin of ·640d. per unit for interest, depreciation, and repairs, to make up the cost of 1·3d. per unit which would be charged for a supply from the central station. As the output is 70,200 units per annum, this represents a sum of £187 4s., or practically 15 per cent. on the £1,250 which we have taken as the cost of the 50-kilowatt plant.

It would appear, then, that there is no need for manufacturers to wait for a central station supply to realise the economy in the cost of power which is offered by Mr. Addenbrooke, except for the saving in capital expenditure. This is, to many of them, a very important point, and the fact that no money will have to be spent on generating plant, and that it will be possible to hire motors from the Midland Electric Corporation should be a great inducement to the introduction of electric power by many who hesitate about making the change on account of the considerable capital expenditure involved.

Water Power for Crieff.

THERE is a water power scheme in the air at Crieff, the source of power being the falls of the Turret, which are on the estate of Sir Patrick Keith Murray, who offered to give the falls for power purposes and had measurements taken which he submitted, says the *Scotsman*, to a London electrician. This gentleman said the falls were not sufficient for the purpose. Mr. Arnot, of Glasgow, had also reported unfavourably of the falls as insufficient to light the town of Crieff. Sir Patrick intimated the London decision to the town in order to save them further trouble and expense. Mr. R. F. Yorke also furnished the Town Council with a report, and he writes to the *Scotsman* to say that no other electrician but himself has been consulted, but that a turbine manufacturer to whom wrong data were submitted stated the power as insufficient. Mr. Yorke writes he has since further explained matters to Sir Patrick, and that the fall is of 300 cubic feet of water per minute through a height of 250 to 600 feet, and not 100 feet as originally stated, which, of course, may make all the difference. Sir Patrick's factor writes, that if the Council are satisfied the fall is still open to them. It is quite possible that an apparent fall of 100 feet may easily be convertible into one of a much greater depth. Assume 300 cubic feet falling 400 feet instead of 100 feet, and at once the net horse-power will be 150 in place of less than 40. Most falls of water are preceded by a series of small falls and rapids, and where the flow is small a pipe line from above the rapids enables the fall to be better utilised, and may also enable the power house to be located well below the falls, the after rapids often being as valuable as the main fall itself. We see no reason to doubt that an oversight may have been made, and the occasion is useful if it draws attention to the fact that there are numerous falls available for power purposes if the system of pipe lines be adopted from above to below the available total declivity. In the Southern Californian water-power plants the pipe lines and tunnels are often brought from an initial point some miles distant, so as to secure a maximum possible fall, and if this can be combined with a dam, the uniformity of flow throughout the year can be thereby very much improved.

SEPARATION OF THE IRON LOSSES OF A TRANSFORMER.*

By Prof. H. S. Carhart.

THE following elaboration of a method of separating the iron losses taking place in a transformer is based on the measurement of these combined losses at two frequencies. A series of measurements is made at each frequency for a number of different voltages. From these two series we may obtain several pairs of equations connecting together the hysteresis and eddy current losses, each pair being taken for the same value of the maximum instantaneous induction, β, of the magnetic wave at the two frequencies. From each pair of equations may be obtained both the eddy current loss and the loss by hysteresis for the voltage corresponding.

To keep the magnetic induction constant, the E.M.F. E must be proportional to the frequency. This is evident from the general formula for the effective E M.F., which is

$$E \times 10^8 = \sqrt{2}\,\pi\, n\, A\, \beta\, N \text{ volts},$$

where n is the frequency, A the cross section of the iron, β the maximum induction, and N the number of turns of wire. If β is constant, E is proportional to n.

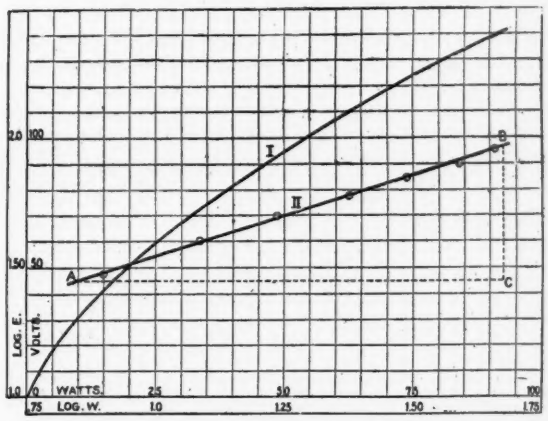
If, then, W and W′ are the total iron losses for the two frequencies n and n', both with the same value of β, we may write for the equations of these losses the following:

$$W = a\,n^2 + b\,n \qquad (1)$$

$$W' = a\,n'^2 + b\,n' \qquad (2)$$

These equations are written on the assumption that the eddy current loss is proportional to the square of the frequency. The loss by hysteresis is, of course, proportional to the first power of the frequency. The constants a and b are respectively the eddy current and hysteresis loss per cycle for the same value of the maximum induction β.

If W′ is the iron loss for an E.M.F. E′, then the value of E for the same magnetic induction in the other series is E′



n/n'. The corresponding watts W lost in the iron at the frequency n may be read from the curve representing the relation between volts and watts lost at that frequency.

The measurements below were made on a 2-kw. Slattery transformer. The current was furnished by the small laboratory alternator, which I have described in another place. (*American Electrician*, November, 1887.) The following series of observations were taken:

Series A. Frequency, 154·7.		Series B. Frequency, 103·7	
Volts.	Watts.	Volts.	Watts.
30	9·0	30	9·8
49	12·8	40	15·1
50	19·4	50	21·3
60	25·2	60	28·4
70	31·6	70	36·1
80	38·9	80	44·5
90	46·5	90	53·1
100	54·2	100	62·2
110	62·7		
120	71·5		
130	81·1		
140	91·5		

* New York *Electrical World*.

Curve I. in the diagram expresses the relation between volts and watts for Series A. It is used to find by interpolation the watts corresponding to the voltages under A in the following table. These voltages are found, as already explained, by multiplying those of Series B by the ratio n/n'. In the present case this ratio is 1·491.

Series B.		Series A.	
Volts.	Watts.	Volts.	Watts.
30	9·8	44·73	16·0
40	15·1	59·64	24·7
50	21·3	74·55	34·75
60	28·4	89·46	45·75
70	36·1	104·37	57·7
80	44·5	119·28	70·6
90	53·1	134·19	84·75

By substitution in equations (1) and (2) we may now obtain seven pairs, viz. :—

$$16 = \overline{154\cdot7}^2_2\, a_1 + 154\cdot7\, b_1$$
$$9\cdot8 = 103\cdot7\, a_1 + 103\cdot7\, b_1 \qquad (1)$$
$$\cdot \quad \cdot \quad \cdot \quad \cdot \quad \cdot \quad \cdot$$
$$84\cdot75 = 154\cdot7^2\, a_7 + 154\cdot7\, b_7$$
$$53\cdot1 = 103\cdot7^2\, a_7 + 103\cdot7\, b_7 \qquad (7)$$

The intermediate equations can be filled in from the table above. Solving these equations for the eddy current losses, we get the following for the frequency 103·7 :—

Eddy loss.	Total loss.	Hystersis loss.	Volts.
1·9	9·8	7·9	30
2·9	15·1	12·2	40
4·09	21·3	17·21	50
4·66	28·4	23·74	60
5·29	36·1	30·81	70
5·81	44·5	38·69	80
7·63	53·1	45·47	90

We have thus separated the losses for the frequency 103·7; the same equations may be used to separate them for the frequency 154·7.

Since these seven pairs of equations involve different values of the magnetic induction β, they may evidently be employed to determine the exponent of β in Steinmetz's formula for the hysteretic loss. For the same value of n the hysteretic loss in watts may be written $W = c_A{}^x$, where c is a constant. Hence:

$$\log W = x \log \beta + \text{constant.}$$

But for the same frequency, β is proportional to the volts E. Let β equal k E. Then, since k is a constant,

$$\log W = x \log k + x \log E + \text{constant}$$
$$= x \log E + \text{constant.}$$

The relation between the logarithms of W and E is evidently the equation of a straight line, and the desired exponent x is the tangent of the angle which this line makes with the axis of log E. The logarithms of the loss by hysteresis and of the corresponding volts of the last table are plotted in Curve II. of the diagram. The tangent of the angle A B C, measured in terms of the two scales on which the logarithms are plotted, is quite closely 1·6.

The method obviously gives better results when the measurements are made on a transformer having iron losses which can be read on the best part of the scale of the wattmeter. The small readings are not so reliable as the larger ones.

I have applied the same method to the small transformer described in the *Electrical World*, September 18th, 1897. The plot of the logarithms gave the same result, viz., 1·6. This confirms Steinmetz's formula for the loss by hysteresis.

TOPICS OF INTEREST TO CENTRAL STATION MEN.

An address upon this subject was delivered on January 19th last by Lieut. Francis A. Badt, before the North-Western Electrical Association, Milwaukee, Wis.; and, as will be seen in the present review, there *is* much not only to interest but also to amuse central station men. He starts off on the rather threadbare—or, as he calls it, "the old, old subject of alternating *v.* direct currents," and appears to distribute his favours about equally between them—a thing, by the way, that very few electrical men are unbiassed enough to do. He then plunges into the troubled waters of "pressure," and after detailing the difficulties he experienced in getting manufacturers to produce a 220-volt incandescent lamp, practically takes the credit for its production as a commercial article. He takes considerable trouble to explain the advantages of a 220-volt direct current two-wire system over the three-wire system, and states that the former is really simpler! We shou'd have thought it unnecessary to explain (!) this to an electrical association. The 220-volt enclosed arc lamp he considers to be a decided advance, as it can be run direct across the mains instead of using two or three in series, and as the arc is three-quarters of an inch long it practically casts no shadow. Obviously, the longer the arc, the less likelihood of shadow *from the carbons;* but he overlooks the fact that the shadows from the supports and spark catchers are much greater than those cast by the lower carbon, no matter what length the arc may be, while the colour of the light produced by any long arc lamp is usually far less pure than that from a short arc for the same expenditure of energy, and in England, at any rate, the colour and steadiness of the light are matters of considerable importance. He is doubtless right in stating that fluctuations of pressure affect a high voltage arc lamp much less than it does a low voltage lamp, and where arc lamps are required to be used on power circuits, there would probably be some advantage in using the higher pressure. Seeing, however, that on lighting circuits a steady pressure is essential on account of the incandescent lighting, its superiority even in this respect is not obvious, and we fancy that the consumer would prefer a lower pressure lamp with a reasonably steady arc and white light. He contends that "you can supply a customer with one lamp without making that lamp depend upon somebody else's lamp, doing away with all series connections." This throws rather a strong side light upon American central station practice, and reminds one of the complaint made many years ago in England by a consumer in a south coast town, that when he wanted to light a single lamp in his bath-room, he also had to light up his drawing room! the lamps being on the same circuit in a parallel series system. He states that "Our friends over the water have declared time and again, and have proven it to us mathematically, that the enclosed arc is no good; that the open arc is of greater efficiency and has many advantages over the enclosed arc, but in spite of these theoretical demonstrations the enclosed arc is the arc to-day in the United States, and the open arc for constant potential circuits is getting out of vogue entirely. It is a back number, and gives us one of the illustrations where theory and practice do not coincide. *The American is, if anything, practical,* &c." Lieut. Francis A. Badt is probably not aware of the large number of enclosed arc lamps in use in England, nor must he assume that the opinions of one or two or half-a-dozen does of necessity represent the opinions of the electrical men of England.

He thinks it will not be very long before they will have an enclosed arc lamp of 500 volts which can be attached directly across the wires of a railway circuit! But why stop short at 500 volts? Why not run up to 2,000, or 10,000 volts for that matter, and connect directly across the feeders of a high tension system? An arc lamp with a 3 feet arc would be a novelty, and *would cast no shadow!* A street lighted with a double row of such lamps would be a sight worth seeing, and we confidently expect practical America to show us the way.

Lieut. Francis A. Badt is in trouble about the "gas cap" of the enclosed arc lamp, *i.e.*, the cover of the inner cylinder, and through which the upper carbon passes. He complains that carbons vary so much in diameter, that either the carbons stick in the hole, or are so loose, that the air gets in too readily, and the life of the carbon is materially reduced. We, in England, would usually surmount this difficulty by specifying for a certain diameter of carbon, and a certain size of hole, and seeing that we got it, or else promptly return the goods to the makers. We presume this remedy has not occurred to practical Americans, and the remedy suggested by

the speaker was the standardising by the Association he was addressing of the diameter of the hole and the carbon. The old story of leading a horse to the water. The Association may standardise, but the maker will supply carbons and gas caps out of standard if the purchaser is not smart enough to see that he gets what he wants. He says that all the above refers to the direct current system, *of course*. Why of course? A pressure of 220 volts is not confined to direct current systems—at any rate in England—neither are enclosed arc lamps, or two-wire or three-wire systems, and if a 500-volt arc lamp is a desiratum for direct current supply, it would be equally advantageous to alternating current systems.

His opinion is—referring now to alternating currents—that the single-phase system will eventually be the system, and makes the astonishing statement that "We have *now* (italics are ours), of course, incandescent lamps burning on alternating currents." (Must we assume that America has not been accustomed in the past to run glow lamps on alternating current circuits?) With alternating arc lamps and single-phase motors he thinks the single-phase alternating system *the* system for large areas The speaker criticised an objection made previously by a Mr. Dow: "That each customer had to have a transformer for the maximum capacity of the dwelling, or whatever it might be, and he cited that as a great disadvantage of the alternating system as against the direct current system." He (the speaker) said, "Now I think that a good deal of that could be avoided in the alternating system by using larger transformers for a number of customers," and goes on to remark that of course it could not be done economically with 50-volt lamps, and it may not be possible to do it economically with 110-volt lamps; but why not use 220-volt lamps?

We should strongly recommend our old friend of years ago to run over to England, for while we are not practical Americans, we have never used any other alternating system than the single-phase for central station supply, and he may be surprised to learn that "banking" transformers is the rule, and is nearly as old as the system itself, that we have never experienced any trouble in running incandescent lamps on alternating current circuits, that stations have been made to pay on 110-volts pressure; and, finally, that 200 or 220-volt lamps are largely used, and have been since their introduction as a commercial article. In conclusion, he draws attention to another threadbare subject, viz., the low efficiency of steam plant, and finally becomes prophetic. "The steam engine of the future (he says) will have a much higher efficiency, of course. It will do away entirely with boilers. It will be a steam engine that burns the fuel, &c."

Then he proceeds to give himself away by saying, "I am not guessing here; but I am just describing an engine which is now on exhibition on the other side of the water," &c., and after explaining that Americans are now trying to buy the patents of this wonderful engine, he goes on to describe an American Utopian city in which street railways will be abolished, and motor cycles and motor buses "running in all directions" (!) on asphaltum pavements, will be the ideal form of locomotion, and the new engine is going to help them realise it! We should like to know something more of this steam engine without a boiler, and which burns its own fuel; but we are content to wait until America has purchased the patents and blown off some of its enthusiasm. We may then hope to get some reliable information, and shall probably find that this wonderful swan is but a very inferior sort of goose after all. We have seen too many of the inventions that were going to revolutionise engineering practice to feel any excitement over one or even half-a-dozen more.

THE ELECTRIC ARC AS A TELEPHONE.

A PAPER by Hermann Th. Simon, in *Wied. Ann.*, Vol. 64, p. 233, describes some exceedingly curious experiments, which show that the electric arc is capable of acting either as a telephone transmitter or as a receiver. Herr Simon first observed accidently in an arc light a peculiar crackling noise, which he traced to the influence of an intermittent current supplying an induction coil, and flowing in a conductor, which ran for some distance parallel to the leads of the electric arc.

Experiments with the rotating mirror failed to show that the electric arc was in a state of vibration; but this was explicable on the hypothesis that the alternating induced current superimposed on the steady current producing the arc, caused so little variation in the light, that the changes could not be perceived by the eye. The alternating current, however, was quite capable of producing changes of temperature in the arc, which expanded and contracted the gases sufficiently to generate sound waves perceptible to the ear. Conversely, it was found that when sound waves were allowed to fall on the arc, variations of the current were produced, which were capable of reproducing the sounds in a distant microphone.

The following arrangement was devised to show these effects. The primary of a small step-up transformer was connected up in the circuit of the electric arc; a microphone and battery were put in circuit with the secondary of the transformer. When the end of a sounding tuning-fork was placed in contact with the microphone, the same note was heard distinctly at the electric arc. Whistling, knocking, singing, and even speech were transmitted and distinctly given out with all the most delicate variations of tone by the electric arc. With loud tones of a certain pitch, the notes given out by the arc were accompanied with a hissing sound. To collect the notes from the arc a glass funnel is held opposite to the arc, and connected to the ears by two tubes.

Herr Simon has calculated the variations of density of the gases which would be produced by the changes of the current, and found that they lie within the limit fixed by Lord Rayleigh for audible sound waves, and he fairly concludes from this, that the notes heard in the arc are due to these variations of density.

When the arc is lengthened, the sounds emitted become essentially louder and more distinct. This is due to the fact that, the resistance of the arc being greater, a greater fraction of the work of the current is expended on the arc, and a larger volume of gas is heated.

In order to show that the electric arc is capable of acting as a telephonic transmitter, the microphone in the above-described arrangement is replaced by a telephone, and the sound waves are concentrated on the arc by a funnel. Speech, singing, whistling, thus directed on the arc, are heard distinctly at the telephone. The explanation of this phenomenon is plain, when it is remembered that the resistance of the arc varies with the density of gases through which the current passes; the variations of the resistance will produce corresponding variations of the current which, by lateral induction in the transformer, are transmitted in an intensified form to the telephone.

We do not recommend this invention for commercial use; the language transmitted through the present telephone is usually heated enough; at least, there is no necessity for passing it through an electric furnace.

TESTING THE RESISTANCE OF THE RAILWAY CIRCUIT.

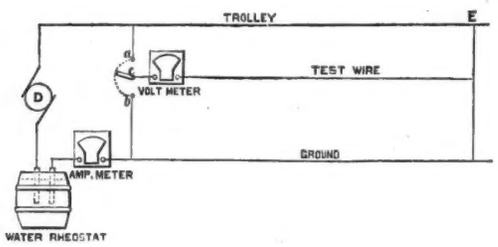
IN a communication to the *Street Railway Journal*, Mr. Sherwood F. Jeter, of Atlanta, says:—

"Having become interested in testing the resistance of the feeder and return circuits of a street railway system, it has occurred to me that a very practical rigging for making such tests, and also one that would definitely locate any trouble that might exist, would be the one outlined in the accompanying diagram. The test wire may be of iron and of any convenient size, and is strung from the station to any point at which it is desired to make tests.

"The tests can only be made at night when the line is not in use. The water rheostat is adjusted so that when the line is short-circuited, a small amount of current will flow, say, from 50 to 150 amperes. Any nice adjustment of the amount of current flowing may be made by changing the voltage of the generator so that the water rheostat need not

be disturbed after once adjusting it. Now, if it is desired to test the resistance of the line from the station to a point E, a connection is made from the trolley wire at E, directly to the ground, and E is also connected with the test wire. The operator at the station now places the double-throw switch (*c*) on (*a*) and the reading of the voltmeter gives the drop on the trolley and feeders from the station to the point E, and likewise by placing (*c*) on (*b*) obtain the drop on the return circuit.

"If the resistance of the test wire is small as compared with the resistance of the voltmeter used (as would ordinarily



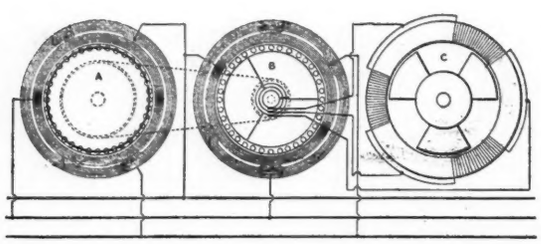
be the case), the effect of this resistance on the readings may be neglected, but if it is desirable to have them absolutely correct, the drop on the entire circuit from (*a*) to (*b*) may be taken, and the sum of the first two readings compared with this and corrected accordingly. The test-wire may also be used for signalling to the station to notify the operator when the line is ready to be tested at the various points. I have never seen an auxiliary test-wire used in making such tests, and would like to get the opinion of some of your readers as to its practicability."

ALTERNATING CURRENT REGULATION.

The *Electrical World* for February 12th, 1898, contains abstracts of two patents recently issued for devices for phase regulation in alternating current systems.

One of these is due to Messrs. C. P. Steinmetz and Edwin W. Rice, and is called by them a phase regulator. It consists in adapting induction machines to the production of leading currents with which to nullify the troublesome, and sometimes harmful, effects of lagging currents due to any inductive apparatus connected to the supply mains.

The arrangement is diagrammatically shown in the figure, in which A represents an ordinary induction motor with short-circuited rotor windings; B is a second induction machine



driven by the motor A, either by belt, or by being direct coupled at a speed above that corresponding to synchronism with the alternating current. The rotor of the machine, B, is wound with open coils connected to slip rings, from which the induced currents can be led off and controlled in a third machine, C, which is a diagrammatical representation of another device for varying the self-induction of the three coils wound on it without altering their resistance. The internal rotative segments in C are arranged to close or open the magnetic circuits around the three windings on the fixed part. This is intended to be arranged for hand manipulation by means of a worm wheel.

The arrangement is based on the principle that inductive circuits, such as is represented by C, when inductively connected, cause lagging currents to pass in the line circuits as long as the secondary of machine, B, runs below synchronism, but cause leading currents when the speed is run above synchronism. In this way, by properly adjusting the self-induction of the coils, C, a suitable leading wattless current can be superposed to exactly balance the lagging wattless component of the line current, and thus bring the power factor to unity as far as the generators and the transmission system are concerned. The machine, A, may be any available source of power, since the essentials of the compensating arrangement are contained in machines B and C.

In practice it is preferable that machines A and B should be direct coupled. If A is a motor, its number of poles should be less than those of machine B in order to run B above synchronous speed.

DOES MOISTURE FACILITATE THE PRODUCTION OF OZONE.

By EMILE ANDREOLI.

Prof. W. A. Shenstone read before the Chemical Society (February 17th, 1898) a paper on "Observations on the Influence of the Silent Discharge of Electricity on Atmospheric Air," which upsets all the notions hitherto accepted regarding the production of ozone.

The learned professor says that oxygen, when diluted with nitrogen, as in the air, yields a very large proportion of ozone; 80—85 per cent. of the oxygen present may readily be ozonised in the presence of moisture, and if great care be taken, as much as 98 per cent. of the oxygen may be converted into ozone, and he adds that the presence of water promotes the formation of ozone, but retards that of nitric peroxide.

My impression has always been—and is still—that one of the conditions for obtaining a good yield of ozone is that the air must be dry, and my experience is that moist air does not give good results.

Prof. Shenstone does not explain how and why the water vapour may assist the production of ozone, while the necessity for using dry air is justified by this fact, that under the action of the silent discharge at a high tension, there is formation of water vapour and hydrogen, this latter being burnt in contact with ozone and producing heat, which destroys a considerable quantity of the ozone produced.

Years ago, a great scientist stated that water vapour absolutely prevents the production of ozone, and that no great yield of ozone can be obtained unless the oxygen is perfectly dry. This doctrine has been universally supported, and for the first time, a chemist advocates the presence of moisture for the transformation of oxygen into ozone.

Considering this question merely from a practical point of view, I will say that I have two ozonisers, the electrodes of which represent a surface of 640 square feet, and which produce a fair amount of ozone when I work them by passing dry air. I am sure that if I ventured to pass moist air between their electrodes there would hardly be any ozone generated, and in no time the apparatus would be out of order.

What is true in laboratory experiments ought to be true also when the experiment is repeated on a large scale. This does not appear to be the case, as there is an absolute discrepancy between the results obtained by Prof. Shenstone and those which are obtained by practice, and everyone interested in the production of ozone on a commercial scale, and in its application to industrial purposes, will repudiate the idea of submitting atmospheric air to the action of the silent discharge, in presence of moisture.

CORRESPONDENCE.

The Burning Question.

Mr. Liversedge lifts a corner of the curtain at Ealing. The wet sludge, says he, is drained through a certain proportion of the refuse, but he opines that this, of course, will not remove as much water as the filter press. It all depends on the drain. Suppose a nice thin layer of the rougher refuse and a free outlet. All that would remain of the sludge would be match stalks, corks and bungs, scrubbing and nail brushes, pieces of soap, candles and kitchen grease, clothes pegs, paper and rags, spinning tops and rubber balls, currants about Christmas time, Gallic literature and an occasional baby. There is a good deal of carbon in this collection which may account for the arc lamps.

A filter press, on the other hand, stops practically the whole of the solids, no matter how fine their state of division. The filtering medium becomes so close grained in a few seconds that a pressure of about 120 lbs. per square inch is required to force the liquid through. Naturally where the press is in use the amount of solids to be burnt is formidable. Why do not other towns adopt that charmingly simple drainage plan then—where a few inches of head on top of a few cinders does the whole business? Is it that they have not yet discovered the secret of dealing thus with their sludge, and at the same time giving satisfaction to the river authorities? As Mr. Liversedge hints, the thing, like the origin of Jeames, is "wrop' in a mistry."

The town of Leyton has ever listened to inventors with a greedy ear. "A Difficult Problem Solved" is a headline over the latest scheme; but the same headline has been used before to describe the exploits in sewage treatment achieved in that Eastern suburb. There was the Astropp system, two stories high, which took in wet sludge at the top, strained it (the liquid being run away in secret channels), dried the solids by hot air, and delivered them into a sack through a spout below, the whole ready and smoking hot for application as valuable manure to hungry lands. One of the great merits of this system was the small amount of solids left. A suburban garden could have taken the whole production for a year, without any symptoms of overfeeding being manifested by the plants.

This earlier solution of the problem was boomed mightily too; under cover of a marquee, solids and liquids disappeared in the most gratifying way; an earl presided, and the ears of the luncheonees were judiciously tickled by optimistic orators. As Mr. Ralph Nickleby grimly remarked, "These things have their uses in business." And, finally, the Astropp system passed into that limbo where hundreds, perhaps, thousands, of solutions of the sewage problem have preceded it.

There is a sentence in Mr. Liversedge's letter which is interesting to note. He says: "Leyton saves over £300 a year in coal in operations connected with her sewage." We should like further particulars of this saving. Is it really net? What are the operations at the sewage works requiring so much power as this sum represents? Are any coals now required? It would serve a useful purpose if Mr. L. would enlarge on this item.

It has been seriously proposed to burn the solids in London sewage, and in a way that only a genius would suggest. When you think of it, if a mere strainer will separate solids and liquids as Mr. L. says it does at Ealing, there is no sense in putting down and running costly precipitation processes with presses to deal with their resultant sludge. You have merely to pass the whole of the sewage as it comes to hand through the strainer, and the separation is effected right away. Accordingly, a man of supreme insight did suggest this way of dealing with London sewage, and published plans showing a kind of dredger with finely meshed buckets working in the sewage. This apparatus dried and burnt the solids as fast as it extracted them. It was discussed in the London press about the time eels were so plentiful in the East London water mains, and I suggested its adoption by that company for ridding their water of these, delivering stewed eels at the other end. This process never got to the marquee and oratoric stage, but expired soon after its inception for want of capital.

J. Hetherington.

Knots.

In the discussion of technical matters loose and inaccurate phraseology is always to be deprecated, and hence it is as well to decide whether a length of "a knot of cable" and "a speed of 6 knots per hour," are or are not correct. I have asserted that they are inexact and wholly unscientific, and make this statement on the authority of such men as Kelvin, Greenhill, and others. "Another Cable Engineer" takes exception to this, and begs to differ, &c. That is, he differs from the distinguished authorities named. If "Another Cable Engineer" were an authority on this matter, his opinion would be entitled to consideration; but he evidently is not, because he gives an altogether incorrect derivation of the knot.

In Harbord's "Glossary of Navigation," a knot is defined as "a division of the log line; so called from the line being divided into equal parts by pieces of string, rove through the strands and *knotted* in order."

The number of knots passing over the ship's rail in a certain number of seconds gives the *rate*, or nautical miles per hour. With that laxity of expression that so distinguishes seamen "knots per hour" were easily substituted for nautical miles, or even miles per hour. This, however, does not invalidate the fact that the original and proper meaning of the knot was that just stated.

Again, "Another Cable Engineer" derives the knot from the circumference of the earth; that is, he makes it a function of longitude. Allowing for the moment that a knot is a sea mile, his definition is still wrong. Harbord says "the length of a minute of the earth's circumference is very inadequate. . . . It was sufficient before the spheroidal figure of the earth was taken into account, and when the assumption was that the earth's circumference was a great circle, the measurement of which had not been accurately determined."

The nautical, or sea mile, or, as it is usually termed, the Admiralty mile (not *knot*), is "the length of a *minute* (not parts or knots) of a degree of latitude," but inasmuch "as the earth is an oblate spheroid, the degree of latitude increases as we advance from the equator towards the pole, and hence its 16th part, a minute, or the nautical mile, also increases (*vide* Robinson's "Marine Surveying.") The mean value of a minute of latitude, or that value on the parallel of 45° is 6,077 feet. The Admiralty have adopted as their standard mile a length of 6,080 feet which is the length of a minute of latitude on the parallel of 48°.

Again, in the latest standard text book of navigation used by the Admiralty, Stebbing's, the knot is strictly defined as a *rate* of a nautical mile per hour. "Knots per hour," then, means nautical miles per hour, per hour—either an acceleration of velocity, or a redundancy of words. It is never *meant* as an acceleration. It is, therefore, a redundant expression, that is, it is inexact and unscientific.—Q. E. D.

"Another Cable Engineer," and possibly others, may regard the whole question as a quibble, but if we admit it is a quibble, why not employ, in defining the power of an engine, so many horse-power *per minute?*

It is true that the expressions in question "have been used for scores of years by naval officers and others." It may interest "Another Cable Engineer" to know that it has been a lax practice for such to speak of minutes of arc either of latitude, longitude, or as shown by a sextant as "miles." This comparison of knots with miles and miles with minutes of arc is most curious and is characteristic of the uninstructed seaman. This misuse of terms is none the less a sure and certain sign of a deficient professional education. Lastly, no modern naval officers or writers of repute on naval service, in which, as I need hardly say, much electrical science is included, employ the objectionable expressions referred to, and I am sure that if "Another Cable Engineer" will look up the subject he will see the error of his ways.

Geo. Herbert Little,
Master Mariner, &c.

Your correspondent, "Another Cable Engineer," in last week's Electrical Review gives the circumference of the earth as 131,385,465 feet. Is not this a mistake, and should it not have been 131,385,464·287 feet? If so, the length to which he has given the name of one knot, and which he

makes out to be 2·66 feet greater than the Admiralty knot should be corrected accordingly.

"Another Cable Engineer" is evidently labouring under the impression that he is replying to Mr. Little's previous letter; but instead of doing so, he gives us the above definition of a new unit of length, and then goes on to explain the use of the log-ship, apparently for the benefit of those who are unacquainted with this old-fashioned device for measuring the speed of a vessel. He sums up by saying that the whole question *appears* to be a quibble.

Now, if he does not know that *his* knot is the nautical or geographical mile, whereas Mr. Little's knot is a speed, and nothing but a speed, let him read Mr. Little's letter through once more, and then ask himself who is the quibbler.

Why not adopt Mr. Little's suggestion and use the word "naut" to express the length known as the geographical mile? One naut per hour would then be a knot, which can clearly not be a nautical mile, but must be a speed; the nautical mile being a naut, not a knot, notwithstanding your correspondent's assertions to the contrary. Surely this is simple!

X. Y.

Testing Accumulators.

If 3 kilowatts are required for a car to move up a gradient with a battery giving 50 volts, it must be evident to Mr. A. Campbell that to move it up the same gradient with a battery reduced to 45 volts will require still 3 kilowatts, and that means plainly more current in the motor armature.

The question is not how this increase is brought about, but whether experts in reporting on tests should not state which of the three conditions referred to were observed: Constant resistance, constant amperes, or constant watts in circuit during test. The first gives highest results, the second lower results, and the third lowest of all. Constant watts would, of course, be obtained in the same way as constant amperes during a test, namely, by varying the external resistance.

The Writer of the Article.

Mr. Ranken's Resignation.

Having heard that the approaching termination of my appointment has by many people been connected with the recent engine breakdown at these works, I should like to point out that my resignation was accepted by the Electric Lighting Committee nearly a week previous to the accident. The Chairman has kindly allowed me to publish his letter in confirmation of the fact.

A. W. Ranken,
Corporation Electrical Engineer, Yarmouth.

[Copy]

7, South Quay,
Great Yarmouth,
March 19th, 1898.

Dear Mr. Ranken,

It is a matter of regret to me that the resignation of your position as chief engineer should be in any way connected with the recent accident at the works. As a matter of fact your resignation was accepted on February 28th, and the accident occurred on March 5th.

Yours very truly,
Rd. Martins,
Chairman of Electric Lighting Committee.

Supply Current for Electro-plating.

I want to do electro-plating direct from the mains supplied me by the Brighton Corporation. I want a pressure of 2 volts and 15 amperes current. The mains come to me at 115 volts. How am I to lower the voltage and at the same time get the 15 amperes necessary to do my work. If you can give me an answer in your next issue I shall feel greatly obliged. Perhaps if you inserted my request in your excellent journal some eminent electrician would not think it beneath him to give a reply, which would enable myself and others to get over our difficulty.

R. T. Dick.

Gas Driven Plant.

As a subscriber to your valuable paper, I should feel much obliged if you would inform me through the columns of your journal as to the proportion of private installations, driven from gas engines *direct* to the dynamo, bears to similar installations driven *through a countershaft* fixed on the floor of the building which is lighted, *e.g.*, when the engines are put down solely for generating the electrical current, and when no other source of power is available.

Gas Engine.

Information Wanted.

Could you let me know where I can find any particulars of any methods of electrical printing with acetate of lead, other than the well-known method used in the electrical printing telegraph, of Bain, with potassium iodide and starch. Thanking you in advance.

T. J. Hughes.

LEGAL.

Crompton & Co. *v.* Liardet.

In the Queen's Bench Division on Thursday last week, before Mr. Justice Day, a claim for £89 3s., balance of account for supplying two electric motors, was brought by Messrs. Crompton & Co., Limited, the well-known electrical engineers, against Mr. J. E. Liardet, a gentleman living at Hyde Park Gate. Mr. McCall, Q.C., appeared for the plaintiffs and Mr. E. G. Hills for the defendant.

Mr. McCall said it was only necessary to bring before his Lordship the point in dispute. In July, 1896, the defendant sent an engineer, named Mr. Rogers, down to plaintiffs' works at Chelmsford to select two electric motors for a yacht of his. Mr. Rogers presented his report to his principal, and plaintiffs subsequently wrote a letter to defendant informing him that they supplied motors of 8·9 horse-power, with 900 to 1,000 revolutions a minute, and motors of 10½ horse-power, of 1,000 revolutions a minute. Mr. Liardet ordered a pair of motors, which were sent in due course. Defendant paid a sum of £100 on account, but the plaintiffs had been unable to obtain the balance from him.

The defendant said that for the past 26 or 27 years he had been engaged in electrical experiments, in which he had been assisted by a Mr. Rogers. In July, 1896, he was fitting up a launch of 65 to 70 tons. This would be the largest yacht afloat driven by electricity. After his assistant had seen certain motors at the plaintiffs, at Chelmsford, he ordered a pair of twin motors from them, which were to have revolutions of from 500 to 1,000 a minute. The motors were delivered about August 16th, and immediately afterwards he forwarded the plaintiffs a cheque for £100. He stated at the same time that the motors were incomplete, and asked that they might be completed. Time passed, and the season became too advanced to have a trial test. Under the circumstances, he wrote to plaintiffs, saying that they must wait for the balance of their account until he had made a trial test of the motors. He found that the motors were not equal. They were to be used for twin propellors, and, therefore, the speed should be equal, otherwise the rudder would always be over, and thus retard the speed. The motors were two right-hand ones, and were not suitable for driving twin propellers in a launch. One motor ought to be a right-hand and one a left-hand motor, in order that both might work properly.

Cross-examined: The motors were to be paid for on delivery, but when he received them he saw at once that they had been wound wrongly. He admitted that he had written subsequently to plaintiffs saying that he hoped to try the motors in April, when, if they were satisfactory, he would pay the balance. But he was suspicious of the motors from the first sight of them.

His Lordship gave judgment for the plaintiffs for the amount claimed.

Williamson & Joseph, Limited, *v.* London County Council.

This was a claim which came before Mr. Under-Sheriff Burchell and a jury at the London Sheriffs' Court last week, for compensation in respect of the compulsory acquirement by the L.C.C., of riverside premises at Coxon Place, Horseleydown, under the Tower Bridge Approaches Act, 1895. Mr. Dickens, Q.C., and Mr. Church, represented the claimant, while Sir W. Marriott, Q.C., and Mr. H. C. Richards, M.P., were for the L.C.C. The claim was stated to be principally regarding fixtures, and it was agreed that the figures with regard to these, should not be placed before the jury, but should be considered by Prof. Robinson for defendant, and Mr. Sherley Price as arbitrators between the parties; the learned Under-Sheriff to appoint an umpire, who should decide between the arbitrators in the event of their failing to agree. Sir Wm. Marriott mentioned that the items referred to amounted to something like £3,560, and, in answer to the learned Under-Sheriff, said the jury would only have to consider the value of the lease and loss of business. The award of the arbitrators or umpire would be added to the verdict.

Mr. Dickens, in opening the case, said the claimants were Messrs. Williamson & Joseph, Limited, who carried on business at the pre-

mises mentioned as mechanical and electrical engineers. The business was established in 1889, in which year the premises were leased for a term of 21 years from March, 1890, at a rental of £180 per annum. Notice to treat was served in July, 1896, but it was not until the latter part of 1897 that the County Council, as a result of negotiations, gave the claimants notice to vacate their premises on or before March 25th next. This date was, however, subsequently altered to June 24th. Counsel proceeded to refer to the various advantages of the premises in question, which were stated to be particularly suitable for the carrying on of the claimants' business. It had not been found possible to secure other premises at a less rental than £300 a year. For the purpose of comparison counsel gave figures, which showed that the sales had been doubled since 1895.

Mr. Edward L. Joseph, manager of the company, said that there had been a steady increase in the sales since the conversion of the business into a limited company. The County Council gave a notice to treat in July, 1896, which had a very injurious effect on their work, because they could not guarantee the date of delivery of an order. The present offices were at 92, Queen Victoria Street, about 12 minutes' walk from the manufactory. He had made about 200 inquiries, and could not find suitable premises equal to those taken in the immediate neighbourhood. He had obtained a new factory at Highbury, four or five miles away, on lease for 21 years, at a rent of £200 a year, but they would have to fit up and repair the premises, and make other alterations, at a cost of £1,500; the accommodation was one-third less than in the other premises. Under the most favourable circumstances the removal could not be carried out under four months, owing to the nature of the fixed machinery, and there being about 1,000 different and small parts that must be skilfully removed. They would have to refuse business for four months, and he estimated his total loss during that time at £2,000. The £1,500 was what they must spend on the new premises; but they did not charge the County Council with all that sum. The notice to treat came at a critical time, when the business was beginning to "turn the corner." The works undoubtedly showed a profit in 1897.

Evidence was given by Mr. Edward Stimson, auctioneer and valuer (Messrs. Stimson & Sons); Mr. Francis J. Bisley, surveyor and auctioneer (Messrs. F. J. Bisley & Sons); and Mr. Frederick F. Smee, surveyor and valuer (of Messrs. Bradshaw, Brown & Co.), as to valuation.

Mr. Henry Sherley Price, member of the Institute of Mechanical and Electrical Engineers, said he averaged two millions a year in valuations of engineering works. He put the damage on loss of trade consequent on disturbance of the business at £2,000, and considered that it would take at least three months to re-organise, remove into the new premises, and get to work on the same basis as at the present moment. During that three months the whole of the establishment charges would be running, whether any work was done or not. He had taken the gross profits according to the 1897 balance-sheet, and divided them by four, producing £870 as part of the expenses that would run on during the three months. He had written to the Council asking them not to stop the business, but they would make no offer.

Some discussion arose as to the agreement which had been come to with regard to the fixtures, Sir William Marriott stating that the County Council had offered the company the whole plant and materials. Ultimately the Under-Sheriff took a note that the arbitrators were to assess the value of all the fixed plant and loose tools belonging to same, all tenants' fixtures and improvements, and the damage to machinery in course of removal. Part of the business could not be carried on at one place while the machinery was being removed.

Mr. F. Charrington and Mr. F. H. Nalder gave corroborative evidence that the business would be practically stopped for three months.

Sir Wm. Marriott, opening the case for the County Council, said the jury had nothing to do with the removal of the fixed plant and machinery, and would only have to decide the value of the lease and the loss of business. As a matter of fact, the premises were let in 1890 at £180 per annum, whereas it was contended on behalf of the claimants that they were now worth £275, which was a very considerable difference.

Mr. Wm. Dalton, of the Surveyor's Department, Scotland Yard; Mr. Andrew Young, F.S.I., valuer to the County Council; Mr. James F. Field, F.S.I. (Messrs. Field & Sons); Mr. Wm. Eve, F.S.I.; and Mr. Henry Stock, F.S.I., gave evidence for the defendants as to the questions of value and convenience.

Prof. Robinson, professor of civil engineering at King's College, was of opinion that the claimant's business could be re-established within two months.

After counsels' speeches and the Under-Sheriff's summing up, the jury gave a verdict for £1,450, divided as follows: £350 for the value of the lease; and £1,100 as loss of trade.

The parties agreed that Mr. F. Terry Horsey, F.S.I., of 11, Billiter Square, E.C. (Messrs. Fuller, Horsey, Sons & Cassell), should be appointed by the Court as umpire in the two heads of claim set aside.

Holophane, Limited, *v.* The Stewart Electrical Syndicate, Limited.

In the Chancery Division on Saturday, before Mr. Justice North, Mr. Swinfen Eady, Q.C., said he had a motion to restrain the infringement of the Holophane patents and from passing off. The defendants appeared, and asked time to answer evidence, and had agreed in the meantime to keep an account.

Mr. Neill, for the defendants, said the patent was a singularly complicated one, and its validity was disputed. It seemed to him a very inconvenient course to try a case of this kind in motion, and he suggested it should stand till trial or further order, he undertaking in the meantime to keep an account.

Mr. Eady said he could not agree to that, as there was a question of passing off. He thought, after hearing the evidence, that his Lordship would grant an injunction even as regarded the patent itself.

Mr. Neill said that really it was pure and simply a patent action.

Mr. Eady: I cannot accept that.

Mr. Neill said that the validity of the patent would shortly come before Mr. Justice Kekewich in an action which was pending.

Mr. Eady said he could not accept an undertaking until the trial, but only until the motion was disposed of.

Mr. Neill said he would give an undertaking until the motion was disposed of.

GLASGOW TELEPHONE INQUIRY.

Sheriff Jameson's report, from which we extract the following, has been placed before the Glasgow Corporation. After referring to the number of witnesses called (84), the Commissioner states that he considered he was not entitled to allow an inquiry into the cost of working. He then gives a detailed description of the exchange system in Glasgow district, and proceeds to answer *seriatim* the question to which his attention had been drawn in his instructions.

(1) Is the Service, As Far As It Goes, Efficient?

He was of opinion that it was not. This was due, directly or indirectly, to the want of a metallic circuit, but a considerable proportion of the enormous number of complaints was not referable to that cause alone, and might have been remedied by more thorough supervision in the central and junction switch rooms, by more care in connection with wires in contact, more prompt attention to complaints against operators, and other precautions. In support of this he refers to the numerous complaints which the correspondence showed had not been manufactured for the occasion.

(2) Is the Service Adequate, and are there a Sufficient Number of Call Offices?

Dealing with this question, he says that no witness was adduced who complained of being deterred from joining the exchange system on any condition as to way-leave or otherwise, and he does not think it is at all unfair in a person who uses the telephone himself being requested to give facilities for the extension of its use to others. In regard to the five years' condition, he says it seems not unreasonable that the company should decline the expense of putting up a wire in connection with their exchange without some security that the expense will not be practically thrown away by a subscriber leaving his premises at the end of a short period. He holds that the number of call offices is sufficient to meet the reasonable requirements of the public.

(3) Is the Price Charged for the Service Reasonable?

After stating the rates, he says: "It appears to me that these rates are not unreasonable, except in some outlying districts, such as Bearsden, Pollokshaws, and others, in which case, I think, they ought to be reduced. But speaking generally, I may say that the rate is what is called the £10 rate for places of business within a half-mile of the Exchange, which was the Post Office telephone rate for distance between a quarter and a half mile up till October 1st last, when a reduction took place to £8. Comparing the rates charged by the Telephone Company in Glasgow with the table of rates in foreign countries, I do not consider that they are excessive. The example which all the Corporation witnesses took as a comparative example was Stockholm. They assume that Stockholm is comparable with Glasgow, and that the rates there should rule the rates in Glasgow. For my own part, I can hardly imagine two more dissimilar places in almost every conceivable respect. It is, moreover, noticeable that a great number of the witnesses who were called for the discontented subscribers said they would not object to the £10 rate if the service was efficient, and if it be the case, as proved by Mr. Gaine, that each message in Glasgow costs 0·57 of a penny, or practically a halfpenny a message, I do not think it can be said that the price is not reasonable."

(4) Is the Inefficiency Due to the Refusal of Facilities by Glasgow Corporation, and is such Refusal Reasonable?

"I am of opinion that the main cause of inefficiency of the present telephone exchange service in Glasgow is, that it is worked by an overhead single-wire system, with an earth return, in a city where there is an enormous amount of concentration of wires to one point greater than even to one point in London, and where, owing to the system of electric lighting in one of the underground railways, an overhead system is peculiarly liable to be rendered inefficient. These objections will be got over by the company making an overhead twin-wire system, but I think it would be most unreasonable to require them to do so. The National Telephone Company resolved, in February of last year, to introduce the metallic underground system in Glasgow, and on February 26th, 1896, applied to the Corporation for assistance, which was refused. My opinion, accordingly, is, that the continued inefficiency of the present telephone exchange service in Glasgow is, in a great measure, due to the refusal of facilities to the Telephone Company by the Corporation of Glasgow for constructing an underground metallic circuit system. The Sheriff examines the evidence given by the representatives of the Corporation on that point, and gives his conclusions as follows:—It humbly appears to me that this evidence is self-condemned (1) so far as the incon-

venience of the public is concerned, the inconvenience of the Corporation laying an underground system for themselves, and the National Telephone Company laying an underground system under the supervision and control of the Corporation, would be in identically the same position. Beyond this, the objections seem to me to be purely of a sentimental and fanciful kind. The objection to giving leave to the Telephone Company because it is a dividend earning company, appears to me quite absurd, when it is considered that the operation proposed is really for the benefit of the public, and will, in that view, cause the company a large expenditure of money; and, further, that the company are willing to pay the Corporation a sum in respect of the leave to be given under their streets. I may remark that the way in which some members of the Corporation speak of the streets as the patrimony of the city of Glasgow is absurd, whether regarded from the point of view of law or of fact. My inference on the whole evidence is, that the true cause of the refusal of the Corporation of Glasgow to allow the Telephone Company wayleave under their streets is that they are resolved if possible to establish a telephone system of their own by means of which they would be able to extinguish the National Telephone Company altogether, so far as Glasgow is concerned, and supply a better and cheaper service to the inhabitants of the present Glasgow district telephone area. My answer to this question accordingly is, that the continued inefficiency of the telephone service in Glasgow is, for the most part, due to the refusal of the Corporation of Glasgow to allow the National Telephone Company to construct a metallic underground system underneath the streets of the city; and I am further of opinion that such refusal is not reasonable or justifiable on grounds of policy or otherwise, unless it be thought that the Corporation are justified in their refusal because they desire to establish a telephone system of their own, and to place the National Telephone Company at an enormous disadvantage in competing with them for the patronage of the public."

(5) Is it Expedient to Grant the Glasgow Corporation a License?

The Sheriff answers this question at length, and concludes as follows:—

"In these circumstances, and apart from the difficulty of the situation, which I shall hereafter advert to, I should have been prepared to state as my opinion that it is not expedient that the Corporation of Glasgow should obtain a license to carry on the business of telephony within the present Glasgow district area, and that for these reasons:—

"1. A telephone service in this country does not exist for the benefit of all classes of citizens, but for that of a limited number. It is therefore not an object to which the "Common Good" of a burgh ought to be applied.

"2. Whether the foregoing proposition be correct or not, it is my opinion that the Corporation of Glasgow are not at present entitled to apply the burgh funds or funds raised on the security of the burgh "Common Good" to the establishment and maintenance of a telephone system outside of the burgh boundaries. To enable them to do so, a special Act of Parliament would be necessary, and it seems inappropriate for the Postmaster-General to grant the license to do something which at present it is otherwise illegal for the Corporation to do. Perhaps this might be got over by the license being given under the condition that it should not be available beyond the boundaries of the City of Glasgow till Parliament has sanctioned the proposed action of the Corporation.

"3. On general grounds of public convenience it is inexpedient to have two telephone systems or two telephonic authorities within the same area, as this leads to the necessity of members of the public subscribing to both systems, or suffering from delay in the transshipment of messages from one system to the other.

"4. Because the establishment of a second telephone system may render the acquisition of the telephones in Glasgow by the Government at the end of 1911 more difficult and expensive.

"5. Because up till this time the Corporation have not produced satisfactory evidence that they could successfully finance and work the proposed system without the risk of putting a new and serious burden on the ratepayers of Glasgow.

"In my opinion the reasonable solution of the matter would be that the Corporation should grant to the National Telephone Company the same facilities for laying a metallic circuit system underground as the large English municipalities have already done, and under similar safeguards.

"But the Corporation of Glasgow at present state that they will never consent to the National Telephone Company being allowed to lay an underground system in Glasgow, and it is clear that unless this is done, the telephone service in Glasgow will continue to be inefficient, which is a state of matters that ought not to be allowed to continue.

"The question therefore arises whether, excepting the present situation, it would not be expedient, notwithstanding all the objections I have above pointed out, that the license they now ask should be granted to the Corporation, throwing on them the whole responsibility of their proposed undertaking.

"One way out of the difficulty would be for the Post Office to establish a telephone exchange in Glasgow themselves, with an underground metallic circuit system of wires. To do so would seem to be authorised by clause 18 of the agreement between the Postmaster-General and the National Telephone Company, dated March 25th, 1896.

"If this course does not recommend itself to Her Majesty's Government, then, in the interests of the public who use the telephone in Glasgow and district, I am of opinion that it would be expedient to grant to the Glasgow Corporation the license they have now requested, provided that they are able to satisfy the Postmaster-General that financially their scheme is sound, and that they have the means of carrying it out."

The following correspondence has passed between the Secretary of the Post Office and Sir James Marwick:—

"General Post Office,
"*March* 16*th*, 1898.

"The Town Clerk, Glasgow.

"Sir,—I am directed by the Postmaster-General to forward to you, for the information of the Corporation of Glasgow, the accompanying copy of the report which was made to the Lords Commissioners of Her Majesty's Treasury by Mr. Sheriff Jameson after his recent inquiry into the telephone exchange service.

"The Duke of Norfolk understands that the Corporation have arrived at the conclusion that they could not confine to their own municipal area the operations of the telephone exchange system which they desire to establish; and he agrees with the Corporation in thinking that there would be grave public inconvenience in instituting an exchange system confined to the area of the municipality alone, and which would exclude from its operation many neighbouring districts in which citizens of Glasgow reside or carry on their business. It is evident, however, to his Grace that, outside the limits of their own jurisdiction, the Corporation might encounter the same difficulties of obtaining wayleaves for the necessary underground wires which have hitherto embarrassed the efforts of the National Telephone Company to make their own system efficient in Glasgow itself.

"Whether this is so or not, however, the Postmaster-General is advised that the Corporation in the present state of the law has no power to carry on the business of a telephone exchange, either within or outside the limits of the municipality, and in these circumstances he is precluded from assenting to the wishes of the Corporation by issuing a license.—I am, Sir, your obedient servant,

S. Walpole."

"City Chambers, Glasgow,
"S. Walpole, Esq., Secretary, "*March* 19*th*, 1893.
"General Post Office, London.

"Sir,—I beg to acknowledge receipt of your letter of 16th instant, enclosing copy of the report which has been made to the Lords Commissioners of Her Majesty's Treasury by Mr. Sheriff Jameson, and intimating the views of His Grace the Duke of Norfolk upon the applications by the Corporation for a telephone license.

"I have submitted your letter and Sheriff Jameson's report to the committee of the Corporation.

"The committee have not had time to consider the report in detail, but they observe that Sheriff Jameson states, in concluding it, that if the Government do not see their way to establish a telephone exchange in Glasgow, with an underground metallic system of wires, he is of opinion 'that it would be expedient to grant to the Glasgow Corporation the license they have now requested, provided that they are able to satisfy the Postmaster-General that, financially, their scheme is sound, and that they have the means of carrying it out.' The Corporation will be glad to have an opportunity of satisfying His Grace upon both these points.

"In reply to your letter, I am instructed to beg his Grace to give consideration to the following statement:—

"1. The Corporation have not arrived at the conclusion that the operations of the Telephone Exchange system which they desire to establish, can not be confined to their own municipal area. The fact is simply this—after ascertaining that the authorities of the various burghs adjoining the city were anxious that the Corporation's exchange, if instituted, should include their burghs, the Corporation, on September 24th last, made an application for the wider area, and they believe it is in the public interest that their exchange should include that area. But they are convinced that, should his Grace unfortunately be unable to grant the license for the larger area, a great public advantage would be secured if the Corporation obtained a license for the municipal area. In that view they desire to remind his Grace that their application of August 12th, 1893, for a license for that area, has never been withdrawn, and is still before him.

"2. The fact that the Corporation made an application in 1893 for a telephone license for the municipal area, and have since frequently, till last autumn, pressed upon successive Postmasters-General the desirability of granting it, is, the Committee trust, sufficient evidence that the Corporation can not concur with His Grace in thinking that there would be grave public inconvenience in instituting an exchange system confined to the area of the municipality. They believe, on the contrary, that a larger number of persons would benefit by a license covering the extended area, and that the public interest would be promoted by the granting of a license for that area. At the same time they believe that the trade and commerce of the city would be greatly benefited by the institution of a municipal service, though its operations were confined within the city boundaries, which extend to 12,000 acres, and embrace a population of upwards of 700,000. Even were the suburban districts excluded from the advantages of the proposed new system, the telephonic facilities which these districts at present possess would not thereby be taken away or diminished. The committee believe that, if the applications which they have made were granted, one result would be to place telephonic facilities for business purposes within the reach, for the first time, of a body of citizens exceeding in number those who at present use the telephone. But the conferring of that advantage could in no degree subject the present subscribers to inconvenience.

"3. The fact that the municipal authorities of the burghs surrounding Glasgow have come forward to ask that the application of the Corporation, extended so as to include those burghs, should be granted, indicates very clearly that no difficulty in connection with

wayleaves in those burghs need be apprehended. The Corporation at present supply those burghs with gas, water, and tramway facilities, and their water and gas pipes and tramway lines are laid in and on their streets, yet no friction has ever arisen regarding these matters. The committee do not entertain the slightest doubt that they could, as in the case of their other extensive undertakings, carry on a telephone exchange as efficiently in the suburban burghs as within the city.

"4. The Corporation cannot admit for one moment that the efforts of the National Telephone Company to make their system in Glasgow efficient have been embarrassed by difficulties in obtaining wayleaves for underground wires. It was not till long after the Corporation, induced by the complaints of the citizens, had applied to the Postmaster-General for a license, that the company even asked such wayleaves. It is to be observed, moreover, that the company has never sought to take advantage of the railways and underground tunnels within the city.

"5. The Corporation are aware that they have no statutory power to carry on the business of a telephone exchange, but, in the event of the Postmaster-General granting them a license, they would be in a position to press upon the Government the desirability of bringing in a public Bill to give corporations the requisite powers; or, if the Government were unable or unwilling to do so, they would themselves promote a private Bill in the next session of Parliament to obtain those powers. The Postmaster-General will not fail to see that, unless the Corporation were able to satisfy Parliament and its officers that a license was actually available, it would be inexpedient in the highest degree for them to incur trouble and expense in asking Parliamentary powers to do what, without the license sought, they could not possibly do.

"As his Grace has been so good as to indicate the grounds on which he has arrived at the opinion intimated in your letter, and as these grounds involve an entire misapprehension of the position which the Corporation has consistently held since 1893, and also of the conditions on which the Corporation could apply for the necessary Parliamentary powers to establish local telephones, I have been instructed to beg that his Grace may be pleased to reconsider their application in the light of what is now stated.

"I have the honour to be, Sir, your obedient servant,

"J. D. Marwick, *Town Clerk*."

BUSINESS NOTICES, &c.

Electrical Wares Exported.

Week Ending March 22nd, 1897.	£	s.
Adelaide	12	0
Amsterdam	90	0
Barcelona. Teleg. cable	359	0
Brisbane	100	0
„ Teleg. mat. ...	211	0
„ Iron teleph. poles	4,735	0
Calcutta...	134	0
Cape Town. Teleg. mat.	160	0
Colombo	43	0
Delagoa Bay	205	0
Demerara	32	0
Durban	95	0
East London	198	0
Flushing	26	0
Fremantle	31	0
Gibraltar	10	0
Hamburg. Teleg. mat ..	20	0
Malta	14	0
Mauritius. Teleg. mat.	29	0
Mossel Bay. Teleg. mat.	30	0
Odessa	35	0
Port Elizabeth	30	0
Singapore	40	0
Sydney	1,269	0
Terneuzen	22	0
Yokohama	443	0
Total ...	£8,373	0

Week Ending March 22nd, 1898.	£	s.
Alexandria. Teleph. mat	212	0
Amsterdam	160	0
Antwerp. Elec. fuses...	151	0
Barcelona. Teleg. wire	46	0
Boulogne	22	0
Brisbane	138	0
Buenos Ayres	65	0
Cadiz	20	0
Calcutta...	1,153	0
Cape Town	1,285	0
Colombo	92	0
Copenhagen	12	0
Delagoa Bay	27	0
Durban	145	0
Flushing	31	0
Fremantle	7,201	0
Genoa	55	0
Gothenburg	341	0
Hong Kong	180	0
Jaffa	20	0
Liban	243	0
Madras. Teleg. cable...	8,200	0
Ostend	53	0
Port Elizabeth... ...	1,616	0
Reval	1,200	0
St. John's, N.B. ...	172	0
St. Petersburg	20	0
Singapore	16	0
„ Teleg. mat.	66,280	0
Sydney	82	0
Wellington	75	0
Total ...	£89,318	0

Foreign Goods Transhipped.

	£	s.
Barbadoes. Teleph. mat.	18	0

Announcement.—The proprietors of *Trade and Industry* inform us that they have secured the services of Mr. John Strahan Smith as the editor of *Trade and Industry*. They also announce that *Aluminium and Electrolysis* and the *Journal of Acetylene Gas-lighting and Carbide of Calcium Review* will be published in future, on behalf of the proprietors at the offices of *Trade and Industry*, 161, Strand, W.C.

Best & Lloyd.—It is announced that for personal and private reasons the firm of Best & Lloyd has been registered as a limited company, taking possession of the Birmingham works and the business on March 31st, 1897. All debts owing by, and all accounts due, will be paid and received by Best & Lloyd, Limited. The *personnel* of the management will be as hitherto.

Birmingham Electrical Exhibition.—On Monday last an Electrical and General Trades Exhibition was officially opened at Bingley Hall.

Books Received.—"Commercial and Domestic Telephony," (A popular guide). By M. Byng, M.I.E.E., and F. G. Ball. Published by General Electric Company and Whittaker & Co.

"Treatise on Chemistry," Vol. II. The Metals. By Profs. Roscoe and Schorlemmer. Published by Macmillan & Co., Limited. 31s. 6d.

Catalogues.—The London Smelting and Refining Syndicate, of 39, Victoria Street, S.W., has issued a pamphlet, illustrating and describing the various descriptions of machinery, materials and chemicals for the electro-deposition of metals supplied by it. This syndicate also undertakes the complete equipment of plating, electrotyping and refining plants. In looking through the list, we observe lead-lined vats, and vats for differential or localised electro-plating, rocking or sliding frames for vats, scouring trough, burnishers, vats for quickening solution, filtering frames, brushes, and a variety of accessorial and other apparatus and fittings. There is a number of interesting illustrations showing some of the operations, and at the end of the pamphlet are general remarks regarding iridium, and on the electro-deposition of cadmium.

Messrs. Geo. Richards & Co., Limited, of Broadheath, Manchester, have issued new illustrated catalogues of their machine tools and appliances, and wood-working machinery. Both lists are dated January, 1898. The machine-tool list describes the firm's planing machines, standard lathes, giving sketches of the various parts, drilling, tapping, slotting, boring, milling, grinding and other machines. The wood-working machinery catalogue deals with band and circular sawing machines, planing wood-turning lathes, boring stand, saw sharpening, moulding, mortising, and various other machines for wood-working.

From Messrs. Francis & Spilsbury, of 20, Bucklersbury, E.C, we have received a copy of Mr. A. P. Lundberg's catalogue which we reviewed last week. On this list Messrs. Francis & Spilsbury's name is printed as London and south country agents. The firm is also agent for Heaton & Smith's patent switches, a list of which is included.

Change of Address.—Mr. Robert Hammond has removed from Ormond House, Great Trinity Lane, E.C., to 64, Victoria Street, Westminster, S.W.

Church Lighting.—The National Electric Free Wiring Company, Limited, have just completed the installation of the electric lighting in the Palace Gardens Church, Notting Hill.

The order for installing the electric light in St. Barnabas Church, Kensington, has been placed in the hands of the same company. The company's patent system of wiring is being used in both cases.

Cowper-Coles's Parabolic Reflectors.—We are informed that the offices of the Reflector Syndicate, Limited, have been removed from 2, Carteret Street, to 39, Victoria Street, Westminster, S.W.

Dissolutions of Partnerships.—Messrs. H. Nunns and E. Sykes (Messrs. Nunns & Sykes, electrical engineers, South Parade, Halifax) have dissolved partnership by mutual consent.

Messrs. P. S. Brook and J. A. Hirst (Brook, Hirst & Co.), electrical engineers, Northgate Electrical Works, Victoria Road, Chester, have dissolved partnership by mutual consent. Mr. P. S. Brook attends to debts.

For Sale.—The Southampton Corporation invite offers for the purchase of a loco. boiler and a slow speed (Robey) horizontal engine now at the electricity works. See our "Official Notices" this week for particulars.

Laying New Mains.—The London County Council is at last taking steps in order to minimise the traffic disturbances, due to the constant breaking up of the streets. In two cases on Tuesday the Council, in sanctioning the laying of new mains by, among others, the Charing Cross and Strand, and the Metropolitan Electric Supply Companies, stipulated that in the main thoroughfares concerned, the work, when once commenced, should be carried on continuously, both by day and night, until completed.

L.C.C. Highways Committee.—The following were elected members of this committee, who are concerned with tramways, telephones and electric lighting, at Tuesday's meeting of the London County Council:—J. A. Baker, J. W. Benn, T. L. Corbett, W. H. Dickinson, J. S. Fletcher, E. A. Goulding, W. Haydon, N. W. Hubbard, Sir John Hutton, W. C. Johnson, R. Parker, R. C. Phillimore, Lieut.-Col. C. Probyn, P. J. Rutland, J. Thornton. It will be noted, with much regret, that the name of Earl Russell is excluded from the list. The noble earl made an eloquent statement on his own behalf, but this was of no avail, and the loss of his services on the committee will be a loss to London as a whole.

Liquidation Notices.—A general meeting of the Electrical Advertising Syndicate will be held at 164, Gresham House, E.C., on Tuesday, April 19th, at 3 o'clock, to hear an account of the winding-up operations from Mr. J. W. Jefferies (liquidator).

The British Electric Installation Contractors, Limited, will hold a meeting on May 2nd at 50, Foregate Street, Worcester, to hear an account of the winding-up operations from the liquidator, Mr. W. J. Hill.

Lists.—From the International Trading Company, of 35, Queen Victoria Street, E.C., who are the sole agents for the Chemnitz Electrical Company, Limited, we have received illustrated price lists, Nos. 1, 2, and 4. These deal with continuous current dynamos and motors; rails, regulators, and resistances; and arc lamps, lanterns, &c. A variety of types of motors and dynamos are shown by means of good illustrations, tabulated figures and prices being given. In List 2, regulating resistances, magnetic switches, motor starting apparatus, automatic current regulator, reversing and starting apparatus, sliding rails, and belt tighteners are detailed. List 4 contains description of the "Chemnitz" arc lamps, for continuous and alternating currents, stage projectors, lanterns, ornamental and otherwise, for arc lamps and lamp accessories.

Ozonisers.—The Electric Ozone Syndicate, Limited, of 5, New Union Street, Moorgate Street Station, is now manufacturing Mr. Andreoli's commercial ozone generators, which are entirely made of aluminium. The advantages claimed for these improved apparatus are the following:—The yield of ozone is large (about 100 grammes per horse-power-hour). There is no rise of temperature in these ozonisers which may damage them, or cause a loss of ozone. These ozone generators can be worked in a continuous manner, and can be made of any size to produce from 100 grammes to 1,000 grammes and more per hour. The syndicate already has several large ozonisers on order.

Personal.—Mr. E. J. Clarke announces that he has severed his connection with the Electrical Power Storage Company as assistant works' manager and works' foreman, after 13 years service, to undertake the management of the "Hart" Secondary Battery Company, Limited, at Crispin's Wharf, Stratford, E. We extend our best wishes to Mr. Clarke for success in his new venture.

Russia.—A company has just been formed with a capital of £50,000, to be known as the Allgemeine Electricitäts Gesellschaft, St. Petersburg. The Allgemeine Company of Berlin is interested in the new concern.

Synagogue Fittings.—The *Jewish Chronicle* contains an article regarding the formal inauguration of the electric light in place of gas at the St. John's Wood Synagogue. The fittings, consisting of 20 3-light electroliers, 10 3-light brackets, four 10-light electroliers, four 3-light candelabras, and two 5-light candelabras, were supplied by the Edison & Swan United Electric Light Company, Limited, and are of unique design, harmonising well with the general character of the interior of the building. They are in the Moorish style, generally resembling Moresque candelabras and lamps. The "Mogan David" has been utilised as an ornament in the design which is pierced in stout brass metal, being solely hand made. The great centre candelabra and 3-light pandants, suspended between the arches of the ladies' galleries, which to heighten the design have been studded with coloured cut-glass gems, give a very pretty effect. The whole of the fittings are of a special and very handsome design.

Telephones in Hospitals.—In our issue of November 12th last, we noted that the Private Wire and Telephone Installation Company's tender for fitting telephones in Guy's Hospital had been accepted. The same company has now been ordered to extend its system all over the premises.

ELECTRIC LIGHTING NOTES.

Aberdeen.—Prof. Kennedy has submitted his notes on the report of Messrs. Smith & Blackman on the proposed electric lighting extensions to the west end and other points. He considers the proposal a wise one. He agrees with the engineers that it is advisable as far as possible to supply current for all purposes in Aberdeen from one station, and concurs with them that it would be better to adopt a high tension continuous current system of feeders, with rotary transformers, than to use low tension feeders working at so small a current density as 500 amperes per square inch. If the increased plant at the electric station will give a pressure of 550 volts, the delivery of the 400 kilowatts to consumers at the west end would require two pairs of cables, each having an area of 0·67 square inches, and all that the Corporation would have to provide would be these cables without any other apparatus either inside or outside the station. In working the station they would simply have to arrange that one of the higher voltage machines should always be working on the west end feeder. The cost of this arrangement would be £5,750. Whether it would be best for Aberdeen to adopt the simple feeder system with the drop of 110 volts, or to adopt the booster system, must depend upon the time at which they expect to be able to deliver current to the west end and the rate at which they expect the demand to come on. As to these points the resident engineers must speak. But the professor advises the Council most distinctly that he should prefer either of these arrangements to the system with 2,000 volts, as he believes it would be not only considerably less in capital cost, but also more efficient in transmission. Electric traction and dust destructor schemes are also considered by the professor.

Arbroath.—The public library buildings are lighted electrically. The plant put down by Messrs. W. Dixon & Co., of Glasgow, comprises a 14 H.P. Crossley gas engine, E.P.S. accumulators, &c. Arc lamps are in the picture galleries, and incandescents in other parts.

Bath.—The Electric Lighting Committee presented a 43-page report at the last Council meeting.

Birkenhead.—The street lamps along the Approach to Woodside Ferry are now lighted by electricity.

Cardiff.—The borough electrical engineer has reported that during February the income was £664 6s. 7d., which was an increase on the amount reported in February of last year. The number of lamps now is nearly 16,000, and 1,420 are about to be added.

Chester.—Mains for the supply of public and private lighting are to be laid in a number of streets at a cost of £950.

Croydon.—The Croydon County Council has requested Prof. Kennedy to report upon the proposed acquisition of the works under the Crystal Palace Electric Lighting Orders, having in view the provision of a supply of current to the South Norwood district as well as Upper Norwood. Prof. Kennedy is also to report upon the cost and best mode of an extension up the London Road as far as Thornton Heath pond.

Dingwall.—The Town Council has agreed not to insist on the production of the specification of the electricity works until the proposed public electric company is formed.

Garston.—The Urban Council on the 17th inst. resolved on the recommendation of the General Purposes Committee to erect a refuse destructor and electricity station on St. Austin's Mount, Garston Old Road, at a total cost of £25,000. Mr. F. H. Medhurst was appointed electrical engineer.

Gourock.—A report on electric lighting has been presented to the Burgh Commission. The estimated cost of an installation would be about £8,600, including plant sufficient to light the whole of the burgh and for the erection of 16 arc lamps for street lighting.

Hackney.—The Vestry had a discussion in committee last week with reference to the proposal of the Electric Extension Company, Limited. The matter was again adjourned.

Hampstead.—The Vestry will apply to the London County Council for sanction to borrow £51,500 to meet the expenditure on the electric lighting capital account up to the 25th inst., instead of £50,000 as previously agreed upon. Another loan of £18,000 to meet the expenditure on the new plant to be laid down before next winter is to be applied for. The Lighting Committee recommended that Wright's patent demand indicators be fixed on all consumers' premises present and future. The recommendation was referred back to the committee for further consideration and explanation. The same committee also reported that, with reference to the letter from Messrs. Ferranti, Limited, on the subject of their contract for the supply of new plant at the central station, they had instructed the Vestry Clerk to inform Messrs. Ferranti that the plant is not at the present time running satisfactorily; that the Vestry is not prepared to fall in with their suggestion that the periodicity of the present machines should be increased; and, further, that the late engineers' strike had nothing whatever to do with the completion of the first contract. Approved.

High Wycombe.—Messrs. Hodges & Todd have been appointed by the Town Council to inspect and report upon the works of the High Wycombe Electricity Supply Company until same are completed.

Horsham.—At the last District Council meeting, a special committee which had made investigations and visited Tunbridge Wells recommended that an application be made for a provisional order, and that Mr. Hawtayne be engaged to prepare a scheme. The report was adopted.

Huddersfield.—The Corporation has appointed a subcommittee to confer with the Elland Council with respect to its application for a supply of electricity for Elland from the Huddersfield works. This month's returns show that there are 43,295 lamps connected at Huddersfield, an increase of 729 over the previous month.

Islington.—Residents in Highbury New Park are asking for the electric light.

The Vestry is to lay mains along a considerable portion of St. James's Road for the purpose of lighting Liverpool Road; to continue the mains and erect lamps throughout this thoroughfare; to lay conduits and mains on one side of the road, and to erect 13 arc lamps (cost £1,260), also to extend the arc lighting through Parkhurst Road, thus completing the line of lighting direct to Holloway Road. Conduits and mains will be laid both for public and private supply on both sides of the road, and 13 arc lamps erected, the total estimated cost of the work being £2,200.

Leamington.—In view of the favourable report made by Mr. Robert Hammond the supply of electricity in the borough is to be undertaken by the Corporation. In their provisional order there will be a clause providing for taking over that portion of the undertaking of the Midland Electric Light and Power Company, Limited, which would be of use to the Corporation.

Leeds.—A Local Government Board inquiry relative to the application of the Leeds Corporation for a provisional order to enable them to issue stock for the purchase of the undertaking of the House-to-House Electricity Company, Limited, will be held at the Town Hall on 31st inst.

Leicester.—At last week's Council meeting Alderman Lennard presented the half-yearly statement of the Electric Lighting Committee, ending December 31st, from which it appeared that the result of the working to the date named, after paying interest on capital, and £581 17s. 4d. on account of sinking fund, was a profit of £449 5s. 10d. Deducting that amount from £1,819 3s. 6d. loss to June 31st last, showed a net loss of £1,369 17s. 8d. The total amount which had been paid on account of sinking fund was £3,741 5s. 6d. The committee also reported that good progress had been made with the apparatus in connection with the works, and it was anticipated that the extension would be completed in good time to meet next season's requirements. With regard to the revenue account, their total receipts were £3,654, as against £3,068 for the corresponding half of the previous year, showing an increase of about £566. In the corresponding half they were charging 6d. per unit, while in the present balance-sheet it was 5d. per unit; that meant a loss to their revenue account of £664. On the expenditure side they had a total expenditure of £1,897, as against £1,436, an increase of £461. The total profit on the profit and loss account was £1,757 for the half-year, as against £1,631 for the corresponding half of the preceding year, so that while their business had increased something like 15 per cent. they had only a net increased profit of £126; after paying interest and sinking fund charges they only had a net profit of £449 as against £457. The net result up to date was that whereas at the end of June they stood with a debit balance on revenue account of £1,819, they now deducted £449, net profit, leaving the debit balance £1,370, and their sinking fund now stood at £3,741.

London.—The Works' Committee of the St. Luke's Vestry has recommended that the principal thoroughfares of the parish—City Road, Finsbury Pavement, Old Street, Golden Lane, &c., be electrically lighted. The matter was by consent referred back.

London County Council.—The gas plant at the Crossness outfall has become worn out and inadequate for lighting the works during next winter. The Main Drainage Committee recommends that the Council agree to the installation of electric light at the Crossness outfall in accordance with the drawings presented to the Main Drainage Committee, at an estimated cost of £7,000; and that tenders be invited for the supply and fixing complete of the dynamos, engines, switchboard, and principal mains, and also for the supply and fixing of the service mains, wiring and fittings.

Lynn.—Prof. Robinson's report estimates the cost of an electric lighting plant for the district at about £15,000.

Marylebone.—The Vestry has instructed the Special Committee to enter into negotiations for the acquisition of a site for a dust destructor and electric lighting station.

Newington.—The Vestry has decided to open a separate account with the treasurer for the electric lighting undertaking, and his offer to place £5,000 at the disposal of the Vestry pending the completion of a loan has been accepted.

Northampton.—The directors of the Northampton Electric Light and Power Company have informed the Town Council that they do not feel in a position to name a price for the sale of their undertaking.

Partick.—The Board of Trade have had under their consideration the application of the Kelvinside Company for a provisional order to light the burgh with electric lighting. The application was opposed by the Commissioners of the burgh and Glasgow Corporation, and the Board of Trade has decided not to proceed with the application.

Portsmouth.—We learn that a number of the leading tradesmen here have sent a petition to the Council against the Electric Lighting Committee's proposal to give facilities to the Free Wiring Company. We are informed by a correspondent that those interested in the local electrical trade look upon this in the light of unfair competition.

Saltburn.—The District Council is giving its consent to the Cleveland and South Durham Assets Company's application for permission to erect poles, &c., in certain streets for electric lighting.

Shoreditch.—The present cable from Great Eastern Street sub-station through Leonard Street is too small and a ·75 cable is to be at once substituted, the cost of the work being about £390. Larger cables are also to be substituted for those at present laid in Great Eastern Street, Paul Street, Curtain Road, Old Street, and other streets where the chief engineer has advised such substitution.

Southport.—A Local Government Board inquiry was held last week into an application by the Council for power to borrow £21,178 for electric lighting purposes. The electric light extensions consist of the erection of a 600-unit engine and alternator combined, the laying down of two main cables, and various other works. There has been a rapid increase in the demand for electricity, and it is estimated that the proposed extensions will meet the requirements of the town for 18 months or two years.

Spain.—Messrs. W. Baird & Co, of Glasgow, who are working the iron ore mines of the Pedroso Company in the Province of Seville, have put down an electric lighting plant at their wharf on the Guadalquiver, at Seville, in order that the loading of ore into the steamers may be carried on both day and night.

Stirling.—The Police Commissioners have asked Mr. R. F. Yorke to give them a report on the water power available at their reservoirs for the electric lighting of the town.

Sunderland.—In the new workhouse infirmary being erected for the Board of Guardians (cost £20,000) provision is to be made for installing the electric light.

Swansea.—Mr. Manville has made his report on the lighting question. The borough surveyor is reporting on dust destructors. The two reports will be discussed in committee shortly.

Tottenham.—The Tottenham and Edmonton Gas Company has withdrawn the electric lighting clauses from the Bill before Parliament.

Walsall.—The Electric Lighting Committee reports a further increase in the number of consumers, and that after paying interest on loans and providing sinking fund, there is a deficiency of £531 17s. 7d. on the past year's business, making with the previous year's loss the total deficiency on the undertaking up to December 31st last, £977 1s. 5d.

Watford.—The Board of Trade has approved of the Council's electric lighting scheme.

Withington.—The District Council on 17th inst. discussed the terms offered by the Manchester Corporation for the supply of electricity. A sub-committee from Withington will confer with the Manchester Electricity Committee.

ELECTRIC TRACTION AND MOTIVE POWER NOTES.

Barking.—Mr. Crooks will bring forward at the next L.C.C. meeting a proposal to refer it to the Highways Committee to consider and report as to the practicability of the Council laying and itself working a tramway along the top of the northern outfall sewer embankment from Stratford to Barking; and also what system of traction would be the most suitable and economical for such a tramway.

Bradford.—The Tramways Committee has appointed Mr. C. F. Spencer, of Walsall, manager for the Bolton Road and Great Horton electric trams, at a salary of £150 a year.

Bristol.—The thirty-eighth ordinary general meeting of the Imperial Tramways Company was held at Bristol on Monday, and Mr. George White, the chairman, in his speech referred to the electrical prospects on several lines. The London United Tramways, Limited, was the one undertaking not actually worked by the company; they had, however, an investment in it, and it was making great strides. The Acton, Brentford, Hounslow, and Hanwell councils had all approved of the proposed new electric tramways. He was personally looking forward to very important results from the development of the United system, inasmuch as they had since received memorials from other districts adjacent to their lines begging them to apply at once for light railways to be worked by overhead electricity, and to connect up with their general system. The small tramway at Darlington, the directors were working on much the same lines as of old, but they would have to apply their minds to substituting electricity in the town also. The Middlesborough, Stockton, and Thornaby electric tramway had proceeded under the able guidance of the managing director and engineer, Mr. Clifton Robinson, and had been completed in so expeditious a manner, that he believed it formed a record piece of tramway work in the United Kingdom. He knew of no previous instance where 15 miles of the best form of concreted and forked tramway had been laid in six months. The power station was well on the way to completion. Electrical arrangements was also in an advanced state, and there could be no doubt the works would be opened in the current half-year, and when finished, would certainly be one of the most complete in this country, or indeed, he might say, in the world. The power house would be a model of its kind.

City and Brixton Electric Railway.—The Bill for the construction of this new electric railway from Brixton to the City, with stations at Brixton Hill, Lorne Road, Kennington Oval, Kennington Cross, Lambeth, St. George's Circus, and King William Street, which the City and South London Company, which will have connections at the Oval and at King William Street, have agreed to work in perpetuity, came last week before a committee of the House of Commons. Mr. Littler, Q.C., in opening the case for the promoters, said the scheme was originally threatened with considerable opposition, but the London County Council, the London, Chatham and Dover Railway Company, and the Lambeth Vestry were apparently satisfied that they would not be injuriously affected, as they were not represented by counsel. The only active opposition came, says the *Times* report, from the St. Saviour's District Board of Works, who raised points as to the depth of soil that ought to be maintained between the tunnels and the roadways, the possible interference with a lavatory, and other small matters. The construction

would be carried on by the shield system which had been so successfully adopted in the case of the Central London Railway and elsewhere throughout the metropolis. He mentioned incidentally that the City and South London Company were now constructing a new tunnel under the Thames in connection with their Islington extension, and that consequently they intended to abandon their original London Bridge tunnel, which would now be available for the growth of mushrooms in the same way as the Waterloo tunnel at Edinburgh, where these succulent fungi are cultivated with considerable success. Mr. Mott, chairman of the City and South London Railway, gave evidence to the effect that there would be no difficulty in raising the capital of £1,200,000 necessary for constructing the railway, along with the stations and other incidental works. After hearing engineering evidence from Sir Benjamin Baker, the committee decided to pass the Bill, subject to the insertion of clauses which are now in course of arrangement with the St. Saviour's District Board of Works.

The City and Brixton Railway Bill, the preamble of which was passed last week, came before the Select Commons Committee on the consideration of clauses the other day. Amendments having been made to meet the objections of the local authorities, the Bill, as amended, was ordered to be reported for third reading.

In regard to Mr. Littler's statement respecting the London Bridge tunnel, the *Pall Mall* has inquired of Mr. Jenkin, the general manager of the C. and S. L., and finds that the facts are as follows:—The London Bridge tunnel forms part of the line from Stockwell to King William Street, which was opened in 1890. It is now proposed to hand over this tunnel to the new Brixton line, to bore another tunnel on the other side of London Bridge, and extend the line to Lombard Street, Moorgate Street, and then on to Islington. The deviation from the present line will be made a short distance from the Borough Station on the City side.

The same Committee also had before them the City and South London Railway Bill, which proposed to authorise the construction of sidings at Clapham, the acquisition of lands for the purposes of the company, and an extension of time in connection with the undertaking, and to empower the sale of a portion of the line to the other company—the City and Brixton. The Bill was ordered to be reported to the House.

Charing Cross and Hampstead Underground Electric Railway.—The Bill promoted by the Charing Cross, Euston and Hampstead Railway Company came before a Select Committee of the House of Commons the other day, but the threatened opposition having been withdrawn, the Bill was referred to the Unopposed Bill Committee.

Clontarf.—A successful trial trip was made on this electric tramline on 17th inst, by the contractors' representatives. Public service was commenced this week.

Coatbridge and Airdrie.—The Light Railway Commissioners will hold an inquiry at Coatbridge on Tuesday, March 29th, into the application of the British Electric Traction Company to lay a light electric railway between these two towns.

Dublin.—The Dublin United Tramways Company have lodged a memorial with the Lord Lieutenant for an Order in Council authorising the extension and doubling of the lines of their system in various districts in the city. The total proposed expenditure amounts to £74,858.

Dudley.—A special meeting of the Town Council was held on Tuesday for the purpose of again considering the tramways question which has been engaging their attention for some time. It may be remembered that the Council opposed the scheme of the British Electric Traction Company when the Light Railway Commission sat at Dudley, because the Council desired to have the tramways in their own hands. The tramway which has given rise to the discussion is the portion of the Dudley and Stourbridge line that runs from Dudley Station to the borough boundary at Hart's Hill; but it is proposed to construct a new line from Queen's Cross, at Dudley, to Bishton's Bridge, at Netherton, that will tap the thickly populated district of Netherton, and provide a means for the Old Hill and Cradley Heath people getting to Dudley. These are the tramways within the borough at the present time. The British Electric Traction Company have an order to construct a line from a place called the "Deck Hole," Dudley, to Kingswinford, and thence to Stourbridge, and the company will also have the portion of the Dudley and Stourbridge line from Hart's Hill to Stourbridge. Whether the British Electric Traction Company should have the whole tramway section has been a subject keenly discussed. The Council have consulted Mr. Reginald P. Wilson, and his report has been submitted to the Council. He strongly recommends the Council to acquire the portion of the Dudley and Stourbridge line to Hart's Hill, and the construction of the new line to Netherton. He considers there are some thousands of pounds of profit in it to the town if electric traction is employed. Using the very best rails, and constructing the line on the best methods, he estimates that the cost of putting the Hart's Hill track in order for electric traction will be £13,150, and the cost of constructing the new line to Netherton at £11,452. He estimates the total capital expenditure to be £50,000, and after allowing for interest and sinking fund, he is of opinion that there will be a net profit of nearly £4,000 per annum, providing that the cost of current is at 2½d. per unit. If the Council should first acquire the tramways, and then agree to lease them to an outside company, then he suggests that the company should pay 2½d. per unit for the electric power, 5½ per cent. on the capital expended, and 15 per cent. on all tickets sold over the Council's sections of the lines. Even then, he thinks, the company would make the handsome profit of not less than £2,300 on a capital of less than £10,000. The Light Railway Commissioners being in favour of giving to the British Electric Traction Company the right to construct the line to Cradley Heath, and the Council having preserved the right of appeal to the Board of Trade, he advises the Council to oppose the decision of the Commissioners before the Board of Trade. The Council has passed a series of resolutions to the effect that Mr. Wilson's report be adopted; that the Council should construct, and as soon as circumstances allow, electrically equip the branch tramway or light railway to Cradley, with the consent of the Rowley District Council, or, in case that authority should object, to the boundary of the borough in that direction, that the Council oppose the application of the British Electric Traction Company for powers to construct the branch line above mentioned; that the Corporation electric lighting scheme be carried out without delay. The Railway, Tramway and Electric Lighting Committee will carry matters through. This means that the Dudley tramways scheme is to be municipalised, and the initial expenditure is estimated at £50,000.

The Finchley Electric Line Rejected.—The Light Railway Commissioners resumed and concluded last Saturday, at the Hampstead Vestry Hall, a three days' public inquiry into the scheme for connecting Finchley and H.ndon with Hampstead by means of an electric tramway. We have already mentioned that there was a determined opposition from the local authorities. The promoters were Mr. J. T. Firbank, M.P., and Mr. Murphy, and the engineers Sir Douglas Fox and Mr. Wragg. In the result the Commissioners said that the necessity for the "light railway" had not been proved, and they therefore declined to grant an order for its construction.

Great Orme.—The unopposed Bill for the construction of a tramway from Llandudno up the Great Orme was before the House of Commons Committee last week. The line would be about a mile long and would cost £20,000.

Halifax.—Major Cardew has been holding a Board of Trade inquiry respecting an application by the Corporation to borrow £20,000 for electric tramway purposes.

The two routes of tramways which are in course of construction will, it is expected, be opened for traffic at Whitsuntide.

Hastings.—The borough engineer has presented a very lengthy report on the tramways question, in which he states that after obtaining information from numerous towns regarding systems, he has come to the conclusion that the overhead electric trolley system is the most suitable for Hastings. Routes are suggested and general considerations are discussed. Single lines, 3 feet 6 inches gauge, with frequent passing places, are recommended. The lines would be 2 miles 1 furlong and 2 miles 7 furlongs long. The cost of construction is given as £7,263 per mile, and the cost of working £6,356 per annum; income £8,424. The committee recommended that the various suggestions made as to the construction and working by the Corporation of the two main lines be adopted; that power be also sought to construct and work the branch lines suggested; that the overhead electric system of traction be used throughout, and that a special committee of seven members be appointed to determine and carry out the details of the scheme. These recommendations have been adopted by the Council, and a special meeting of the Council is to be held on April 20th next.

Ilkeston.—The Council (sitting as General Purposes Committee) has passed a resolution in favour of tramways for the borough, steps to be taken by the Council in that direction. The Town Clerk is to collect details as to the working of tramways at Dover and elsewhere.

Leicester.—The Town Council has appointed a special committee to consider the advisability of purchasing the tramways, and also to report on a suitable system of traction.

Manchester Underground "Electric."—A *Manchester City News* writer has seen plans of an underground electric railway for Manchester, "which only await the capitalist in order to be carried out." The first part of the scheme is to connect the various railway stations by means of an inner circle in the city—a length of 3½ miles. The second part of the scheme would be an outer circle 8 miles in length.

The Metropolitan Underground.—The Great Western Railway Company, which runs 17 trains per day over a part of the lines of the Metropolitan, has raised objection to the Bill applied for by the company authorising electrical equipment. The objections came before the Court of Referees at the House of Commons on Monday. The Great Western trains running on the line are necessarily subject to the Metropolitan Company's approval, and the Great Western appears to think that when the line is electrically equipped they also may be compelled to change their system to electricity.

Paisley.—The British Electric Traction Company, which has made a conditional agreement with the Paisley Tramways Company, has laid its proposals before the Town Council. It is proposed to extend in the direction of Johnstone in the west, Glasgow boundary in the east, Renfrew in the north, and Potterhill in the south, electricity being, of course, employed. A lease of at least 23 years is suggested, and the company offers to negotiate for the supply of electrical energy from the Corporation works when put down. Mr. Teague has the letter in hand for report. The tramways company transfers its undertaking as at January 1st, 1898, the price being £18,591 odd.

Plymouth.—The Plymouth Corporation will oppose the Devonport, Plymouth, and Stoke Tramways Bill.

Riesengebirge.—The whole Silesian slope of the Riesengebirge, including the Upper Iser, belongs to the Warmbrunner line of the Schaffgotsch. The managers of this property have decided, as much in their own interest as in that of

the tourist, to consider the question of opening up the Riesengebirge by a Kamm railway and a Schneekoppe railway. The building of the lines will commence as soon as possible, and it has been decided to work them by electricity. The immense energy of the larger streams, which descend the Riesengebirge, is to be utilised for generating the electricity, and in two or three years a network of light electric railways will render all important points of the Riesengebirge accessible; at the same time, the exploitation of the vast forest lands will be facilitated by this system of railways, which will be an immense improvement on previous methods of transport. The new network of railways will be connected to existing lines at six points; in the west at Warmbrunn, Hermsdorf and Petersdorf, and in the east at Schmiedeberg, Arnsdorf and Krummhübel. The Koppe and Kamm line will connect on to the branch line, Tillerthat, Krummhübel, mount in bold curves, past Querseiffen, to Brotbande, run past the highest houses on the beautiful Brückenberg, to Kirche Wang, then wind past the Schlingelbande and the "Eyes of the Mountain" to Hamppelbande, and, finally, in serpentine windings, mount the last slope of the Kamm, and reach a station near the Reisenbaucle. From this the line will run round the steep Schuttkogel of the Schneekoppe, in a double spiral, up to the Koppe houses. May we be spared this trip!

St. Helen's.—Having regard to the changes to take place in the immediate future in the method of traction, in the character of the service generally, and the consequent outlay required by the company, no dividend is to be paid by the St. Helen's Tramway Company for the last half-year.

Whitley and North Shields.—It is proposed by the British Electric Traction Company, Limited, which has lately taken over the North Shields and Tynemouth tramways, to build a light electric railway along the coast road between Whitley, Tynemouth and North Shields.

TELEGRAPH AND TELEPHONE NOTES.

Cable Communication to Australia.—According to a *Pall Mall Gazette* correspondent "A Departmental Committee, including representatives of the Colonial Office, the War Office, the Admiralty, and the Colonies, is now sitting under the presidency of Sir William James Lloyd Wharton, K.C.B., Hydrographer of the Navy, to consider the proposal of the Eastern Telegraph Company to lay an all-British cable connecting London with the Cape, Natal, Mauritius, and Australia, as an alternative scheme to the proposed Pacific cable from Vancouver to Australia and New Zealand. The Imperial representatives regard the two lines chiefly from the strategic standpoint, and it is understood that there is almost a consensus of opinion in favour of the Cape-Australian scheme, especially if a connection be established with India and Ceylon. There is a division of opinion in the Australasian colonies, the eastern provinces favouring the Pacific project as supplying an entirely new line with extensive commercial possibilities in the near future, and the western colonies being more in sympathy with establishing a direct connection with South Africa and the Mauritius. The cable companies require an extension of the existing subsidy of £32,500 a year for a fresh term of years in the event of their incurring the very considerable cost of constructing the new line. New Zealand, as well as the eastern colonies of Australia, object to this guarantee, and would prefer that any fresh financial responsibilities should be in connection with a trans-Pacific route. It is doubtful, however, if the Imperial Government will be disposed to contribute a third of the cost of that line at present. Hence it may be somewhat difficult to reconcile the conflict of interests."

The Iceland Cable.—In regard to the scheme of the Iceland Cable Company the *Standard* remarks that the Danish Government is willing to guarantee £5,000 a year for 20 years, and the British Government is to be asked to guarantee £3,000 a year for a similar period. Mr. Doughty, the member for Grimsby, intends to bring the question before the attention of Parliament; and it is also to be discussed at a meeting of the Sea Fisheries Association, at the Fishmongers' Hall, on March 31st. It is expected that the Government will show some unwillingness to subsidise a foreign company.

Interruption of the Cape Cables.—We have again to add to the long list of interruptions and delays which have occurred from time to time in the telegraph communication with the Cape. On the 17th current we were officially informed by the Berne Office that "the St. Thomé-Loanda cable will be interrupted intermittingly during the next three or four days for renewal purposes, traffic will be forwarded by the East or West Coast routes when necessary, without alteration of rates." Two days later we heard from the same source that the Lorenzo-Marques-Durban cable was interrupted, that the repairs to the St. Thomé-Loanda cable were not yet completed, but "communication with South Africa is maintained by the Portuguese landlines from Lorenzo Marques to Transvaal." It will thus be seen that both the East and West Coast routes were interrupted, and our communication with Cape Town was entirely depending on the some 1,000 miles of landline, the greater part of which passes through foreign territory. Although this state of affairs did not last long, for later in the day the St. Thomé-Loanda cable was repaired (thus restoring the West Coast route), it proves once more the absolute necessity of laying another cable to the Cape, and, as we have previously pointed out, the cable company who is, and has been since its existence, in receipt of large subsidies from the English, Cape of Good Hope, Natal and Portuguese Governments, should be quite able to carry out the work without further "privileges" for doing so.

Interruptions to Australian Landlines.—Referring to the list of interruptions to the Australian trunk landlines recently published by us, we are able to furnish our readers, from Australian papers just to hand, with a little more information on the subject, and the following extracts from the Australian press will show that there is every cause for the general dissatisfaction which has been expressed, both in England and Australia, with the existing system of telegraphic communication between the great commercial centres of both countries:—

February 8th.—"The Postmaster-General, Adelaide, advises:—'Port Darwin line still interrupted. Our West Australian lines are working badly owing to thunderstorms. Very little prospect of getting cable business through.'"

No cablegrams from London were received in Sydney on February 8th.

February 10th.—"The Postmaster-General at Adelaide advises:—'The Port Darwin line is interrupted north of Woodnadatta since 11.20 p.m., Wednesday. Probably caused by floods.'"

No cablegrams from Europe were published in Sydney on February 11th, so we presume that the West Australian line was also interrupted.

February 11th.—"Adelaide. The Postmaster-General reported this morning:—'Fault removed between Oodnadatta and Charlotte Waters, 9.5 a.m. Line still interrupted between Barlow and Tennant's Creeks since 5.35 p.m. yesterday.'"

Later.—"Communication restored Port Darwin line at 2 15 p.m."

In the same paper we read:—"Port Darwin, Friday, February 11th:—'The Cable Company's steamer *Recorder* has been here for some days past repairing the cable.'"

February 14th.—"Perth, Saturday (February 12th). Great dissatisfaction is expressed here at the unsatisfactory working of the Inter-Colonial Telegraph line on the South Australian side. Many messages are 24 hours late, and there is great difficulty in obtaining share quotations. The local exchanges are completely paralysed. For several nights lately the lines have failed altogether, or else worked very badly."

It will be seen that the scanty information we are able to make known is only gathered from such particulars as appear from time to time in the Australian press. As we have frequently pointed out, it is seldom, if ever, that any notice of interruption to the Australian trunk landlines is furnished by the Bureau International des Administrations Télégraphiques. It will be noticed that what information is published in Australia emanates from Sir Charles Todd, the Postmaster-General of South Australia, yet that gentleman, in answering a protest from the London Chamber of Commerce towards the end of last year concerning the delays in the transmission of cable messages to and from South Australia, says that "delays have rarely occurred," and that he does not "anticipate any further complaints." We do not see how that statement can be reconciled with the following extracts from letters in the Australian papers we are now dealing with:—

"During the past six or seven months the interruptions of the overland telegraph line to Port Darwin have been sufficiently frequent to cause very serious inconvenience to business people. On every such occasion the utter worthlessness of the Roebuck Bay line as an emergency one has been fully demonstrated. It would therefore seem that the Eastern colonies must look to a Pacific cable if they desire an alternative service of any value, and free from the misleading information supplied too frequently from Adelaide."

Another writer says:

"The increasing frequency of the interruptions to the cable service to Europe, both as regards the submarine system and the landlines, would, one might imagine, be sufficient to draw serious attention to the faultiness of the present means of communication much more strongly than it appears to. To many business men it must mean immense loss."

In commenting on Sir Charles Todd's reply to the secretary of the London Chamber of Commerce, the writer continues:—

"If delays are occasionally due to heavy business, it is clear that the lines are insufficient for the purpose for which they are designed, and therefore should have their carrying powers increased. When the West Australian landline was connected from Roebuck to Adelaide, it was intended as an attempt in this direction; but it has proved utterly unreliable, being more often out of order than not."

The same correspondent goes on to show that an alternative line for telegraphic communication between England and Australia is a necessity, and says:—

"Such a route would be offered by the Pacific cable. In the event of war being declared, the Pacific cable would in all probability be worth many times the sum we seem so reluctant to grant, even if it only remained open sufficiently long to give us warning."

We have for years advocated the laying of the Pacific cable, so that the principal centres of population in Australasia might be entirely independent of the two unreliable lines which run across that vast continent to meet the submarine cables; besides which it would be invaluable for strategic purposes, and we trust, that now the Australian Governments are reported as willing to take action in this direction, some definite movement may soon be made.

The Telephone Service.—In the Commons last week, Sir Mark Stewart asked the Secretary to the Treasury, as representing the Postmaster-General, whether it was the practice of the Post Office to substitute a telephone for a telegraph where the guarantors have signed an agreement with the Post Office for a telegraph service; and if it were so, would he state the reasons. Mr. Hanbury, in reply, said it has been judicially decided that the definition of telegraph includes a telephone. In agreements of the kind referred to there is no provision as to the particular form of instrument to be used. The guarantee for a telegraph extension is based on the most suitable method of serving the office, and if a telephone is used it is

because it offers advantages over other forms of telegraph apparatus, either in regard to initial cost, maintenance, or working.

The Association of Chambers of Commerce meeting in London last week, passed a resolution pressing upon the Telegraph Department of the Government the necessity of promptly increasing the telephone trunk line service between mercantile centres.

The Huddersfield Corporation has had a discussion *re* telephone matters, particularly regarding rates. The Telephone Company is substituting underground for overhead wires, and reconstructing the plant on the twin-wire system. The North Staffordshire Chamber of Commerce has also been discussing the inefficiency of the service and the high charges. Mr. Gaine and Mr. Coleman met the Chamber the other day, and it was explained that there was no prospect of reduced charges, as the plant was to be constructed on the twin-wire system in order to improve the service.

The Pacific Cable.—The British Empire League meeting at Ottawa on 10th inst., passed a long resolution regarding the Pacific cable scheme, urging the Government and Parliament of Canada to continue such action as may be necessary to secure the early commencement of the cable. A committee was appointed consisting of Sir Sandford Fleming, Colonel Denison, Messrs Casey, M.P., Hughes, M.P., and Principal Grant, to wait upon the Government for the purpose of presenting the resolution and urging prompt action.

Telegraphic Interruptions and Repairs:—

Cables.	Down.	Repaired.
Brest-St. Pierre (Anglo, 1869)	April 6th, 1893 ...	...
West Indies—		
St. Croix-Trinidad ...	Nov. 30th, 1896 ...	
Paramaribo-Cayenne ...	Jan. 27th, 1898 ...	March 19th, 1898.
Amazon Company's cable—		
Parintins-Itacatiara ...	May 5th, 1896 ...	...
Obidos-Parintins ...	Dec. 7th, 1896 ...	...
Cable beyond Obidos ...	March 9th, 1898. ...	...
Cyprus-Latakia	Feb. 10th, 1898 ...	...
San Thomé-Loander... ...	March 17th, 1898 ...	March 19th, 1898.
Gibraltar-Tangier	„ 19th, 1893 ...	...
Lourenco Marques-Durban...	„ 19th, 1898 ..	...
Landlines.		
Trans-Continental line beyond Masol	March 12th, 1896 ...	...
Cartagena-Barranquilla ...	July 4th, 1896 ...	...
Bolinao-Manila-Laminos ...	March 9th, 1898 ...	March 21st, 1898.
Saigon-Bangkok	„ 15th, 1898 ...	March 16th, 1898.
„ „	„ 18th, 1898 ...	„ 19th, 1898.
Majunga-Tananarive ...	„ 15th, 1898 ...	„ 16th, 1898.
Fao landlines...	„ 21st, 1898 ...	„ 22nd, 1898.

The Telegraph Clerks.—The London committee of the Postal Telegraph Clerks' Association issued last week a statement in reply to the circular of March 15th issued by the Postmaster-General. The association states that many points are not yet dealt with, and pressing grievances remain unredressed. As examples they particularly draw attention to two points—classification and holidays.

FORTHCOMING EVENTS.

1898.

Friday, March 25th, at 8 p.m.—The Institution of Civil Engineers (students' meeting). "Internal Governor Friction," by H. O. Eurich, Stud.Inst.C.E.

At 5 p.m.—Physical Society at the rooms of the Chemical Society, Burlington House. (1) "On the Circulation of the Residual Gaseous Matter in a Crookes Tube," by Mr. A. A. Campbell Swinton. (2) "On some Improvements in the Roberts-Austen Recording Pyrometer, and Notes on Thermo-electric Pyrometers," by Mr. A. Stansfield.

At 8 p.m.—Electro-Harmonic Society. Last Smoking Concert of the season at St. James's Hall Restaurant.

Monday, March 28th. Last day for Darwen Corporation electric light plant tenders.

Wednesday, March 30th, at 8 p.m.—Society of Arts. Prof. S. P. Thompson, on "Telegraphy Across Space." Mr. J. W. Swan, F.R.S., will preside.

Royal United Service Institution. Captain J. N. C. Kennedy on "Wireless Telegraphy."

At 7.30 p.m.—Institution of Electrical Engineers. Students' meeting. Paper on "Electrical Instruments," by M. R. Gardner, Student.

Thursday, March 31st.—Last day for Hampstead extension plant tenders.

Royal Institution of Great Britain. Prof. J. A. Fleming, M.A., D.Sc., F.R.S., M.R.I., on "Recent Researches in Magnetism and Dia-magnetism." (Lecture V.).

At 8 p.m.—Chemical Society, Burlington House. Annual general meeting.

Friday, April 1st, 8 p.m.—Institution of Junior Engineers at the Westminster Palace Hotel. Paper on "Mechanical Refrigeration," by Mr. J. T. Burrell, of Peterborough.

Saturday, April 2nd, 11 a.m.—Visit of the Institution of Junior Engineers to the Thames Iron Works, Blackwall.

Tuesday, April 5th, at 8 p.m.—Röntgen Society, at 11, Chandos Street, Cavendish Square, W. Paper by Mr. James Wimshurst upon "The Influence Machine and its Advantages for lighting X-Ray Tubes."

CONTRACTS OPEN AND CLOSED.

OPEN.

Ashton-under-Lyne.—April 5th. The Corporation invites tenders from firms willing to undertake the free wiring of premises in the Borough. Consulting engineers, Messrs. Lacey, Clirehugh & Sillar, 78, King Street, Manchester. See our "Official Notices."

Belgium.—March 30th. Tenders are being invited by the municipal authorities of Ghent for the supply and erection, &c., of a complete installation for the electric lighting of the town dock. Particulars may be obtained from, and tenders to be sent to, l'Hotel de Ville, Ghent, Belgium.

Belgium.—April 1st. The Municipal Authorities of Seraing are inviting tenders for the concession for the supply of electrical energy in the town for public and private lighting purposes during a period of 30 years. Particulars may be had from, and tenders to be sent to, the College des Bourgmestre et Echevins, Seraing, Belgium.

Bournemouth.—The Corporation wants tenders for the electric lighting of the pier and pleasure grounds. Particulars *re* plant, &c., are given in our "Official Notices" March 18th. Borough engineer, Mr. F. W. Lacey.

Bournemouth.—April 4th. The Corporation wants tenders for motor vehicles for the collection of house refuse, &c. Borough engineer, Mr. F. W. Lacey. See our "Official Notices" March 18th.

Darwen.—March 28th. The Corporation wants tenders for the supply of steam engine and dynamos, piping, accumulators, switchboards, mains, arc lamps, pillars, &c. See our "Official Notices" March 11th.

Denmark.—March 30th. Tenders are being invited until the 30th inst. by the Danish Telegraph Department in Copenhagen for the supply of 56 tons of copper-bronze wire, 4 mm. diameter, and 42 tons of copper-bronze wire, 3½ mm. diameter. Particulars may be obtained from, and tenders to be sent to, Die Telegraf-directorale Tekniske-afdeling, Copenhagen.

Derby.—April 12th. The Corporation wants tenders for the electric wiring of its Ford Street yard and premises. See our "Official Notices" March 18th.

Derby.—April 11th. The School Board want tenders for the electric wiring of the Traffic Street Board School, Derby. Particulars from Mr. J. E. Stewart, Corporation electrical engineer. See our "Official Notices" last week.

France.—March 30th. Tenders are being invited by the municipal authorities of Paris for the supply of the electrical conductors, required in connection with the electric lighting of the Square Vaugirard. Particulars may be had on application, and tenders to be sent to, l'Hotel de Ville, Paris.

France.—March 31st. Tenders are being invited by the Municipal Authorities of Saint Chamond (Loire) for the concession for the lighting of the public streets of the town, either by gas or electricity. Particulars from, and tenders to be sent to, La Mairie de Saint Chamond (Loire).

Hampstead.—March 31st. The Vestry wants tenders for the supply and erection of one or two steam alternators, switchboard panels, two induced draught wet back boilers, feed water heater, steam and exhaust pipes, feed pumps, 50 kw. exciter, and a feed water softener. See our "Official Notices" March 18th for full particulars.

Leyton.—April 4th. The District Council wants tenders for the supply of two dynamos, one transformer, two gas engines and connections, and switchboards for extension of the electricity works. Electrical engineer, Mr. H. C. Bishop. See our "Official Notices" March 18th.

Manchester.—April 4th. The Lancashire and Yorkshire Railway Company is inviting tenders for various stores. The following are a few of the items:—5. Copper; 7. Copper tubes for boilers; 8. Copper tubing; 29. Signal and telegraph fittings; 30. Signal, telegraph and electric light wires. Samples may be seen and forms of tender and further particulars obtained at the Stores Department, Osborne Street, Manchester.

Shoreditch.—April 12th. The Vestry want tenders for the supply and erection of arc lamps and accessories, also for electric cable. Electrical engineer, Mr. C. N. Russell. See our "Official Notices" this week.

(*Continued on page* 409.)

MESSRS. MAVOR & COULSON'S WORKS, GLASGOW.

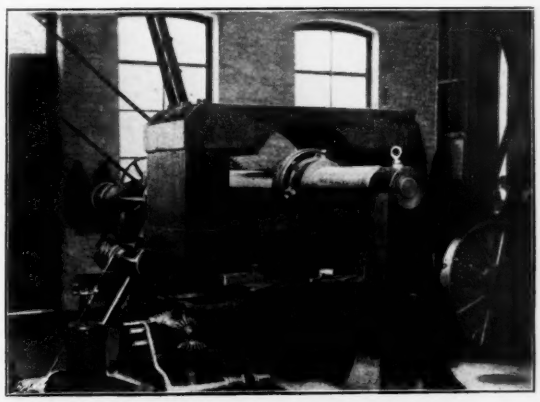
The new works of Messrs. Mavor & Coulson, Limited, have been recently opened, and as they are equipped with the most modern plant some details of them may be interesting. The works are erected on ground purchased by the company from Messrs. Clark & Co., Limited, who formerly used the site for their Mile End Thread Works. The works are 1½ miles distant from Glasgow Royal Exchange, and are within three minutes' walk of the Bridgeton Cross Stations of the North British and Caledonian Railways.

The company's manufacturing business was formerly carried on in their premises in Orr Street, Bridgeton, which premises together with the machine tools there were held on lease. During the company's tenancy of these works patterns were developed and standardised, and methods of production systematised. At the expiry of their lease last year the company was therefore in a singularly favourable position to undertake the design and equipment of a new factory for their specialities in electrical machinery and accessories. In the general arrangement of the works and selection of machinery, the directors have had the advantage of an intimate knowledge of the most recent American and Continental practice, and of their own special requirements. The result has been the building and equipping of a factory, which is the only one of its kind in Scotland, which provides facilities for the rapid, economical, and accurate production of high-class electrical machinery, and is probably not surpassed by the best and most recent factories in the country. The establishment of this new factory for the extensive manufacture of electrical plant in Glasgow is an important addition to the long and varied list of industries which have been located in and around the city.

Generating Plant for Shop Driving.

The existing buildings formerly used for the thread factory and stores have been partially utilised for the new factory. The ground formerly occupied by the engine and boiler house, wood stores, bobbin shop, packing case warehouse, &c., has been cleared, and a spacious new shop and smithy, brass foundry and moulding shop have been erected. The machine shop is 160 feet long by 75 feet wide, and is covered by a single span steel roof, glazed all over and supported by 14-inch brick walls, and cast-iron columns carrying the crane girders which are spaced at 40 foot centres. The lofty roof gives a spacious and airy workshop, while its steel and glass structure and the side windows in the walls provide exceptionally good and uniform lighting. The heating is effected by cast-iron pipes supplied with exhaust steam from the engines. On either side of the space swept by the crane is erected a gallery, which will be used on the one side by the pattern making and carpentry department, and on the other by the store department for finished stock. The design is to ultimately use these galleries for light machine tools, and accommodate elsewhere the two departments mentioned. The large centre bay is floored with granolithic, and the two side bays under the galleries are floored with double pine planking laid on joists. The machinery in this department is driven by 10 electric motors. None of the shafting is driven direct from the steam engine, with the exception of a short length on the testing engine. It is hardly necessary to point out the advantages gained by the use of electric motors in this department.

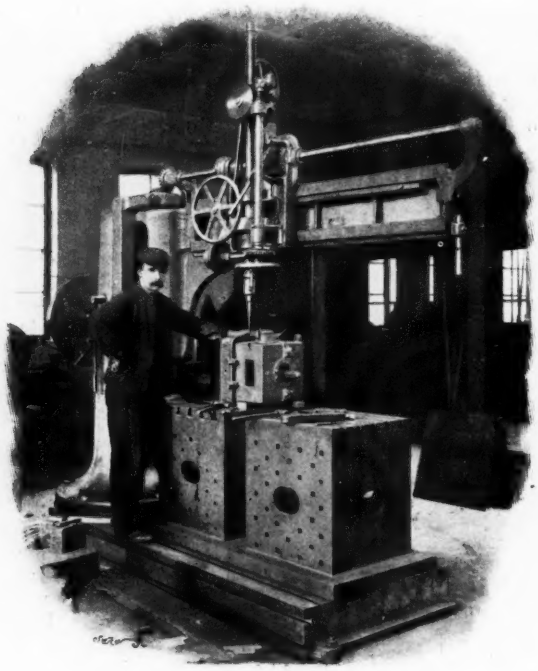
A special feature in this department is the extensive use of milling machines and other special appliances for labour saving. While special appliances do not in any sense dispense with the necessity for skill on the part of the workman, they permit of the use of a class of labour more easily available than that of a fully trained and equipped all round tradesman. The machines and tools are arranged with a view to the utmost accuracy in work without the necessity for individual measurements by the operator, the machines themselves being provided with measuring devices in which dimensions can be read off with ease and accuracy down to $\frac{1}{2000}$th of an inch. The use of such machinery necessitates a separate department, with special appliances for making new tools and for keeping the working tools in order. This is provided in the tool room in the north-west corner of the main shop, where a staff of skilled men are constantly employed in these operations. The antiquated practice of keeping a machine standing while the operator is grinding his tools or awaiting their formation by the tool smith is thus entirely abolished. It is found that the use of highly finished and accurately made machinery is a valuable education to the men operating it. The tendency being to assimilate the character of the work produced to that of the machinery producing it, and to keep the shop and all its surroundings up to a high standard of cleanliness and order. These tendencies inevitably reflect their characteristics upon the finished product.



Horizontal Boring Machine Boring Magnets.

The electric crane, which sweeps the whole of the centre bay of the shop, is capable of lifting about 10 tons, and can traverse the whole length of the shop from start to stop in one minute. It is fitted with a motor for each motion, and is controlled by a man who sits in a cage under one end of the crane girder. The controlling gear consists of three liquid switches, which give command over all the required motions, and which enable the driver to operate any motion at any speed, either simultaneously or independently of the

other motions. The entire absence of reversing clutches and other complicated mechanism renders the crane exceedingly easy to manipulate. An ordinary mechanical labourer



Radial Drill.

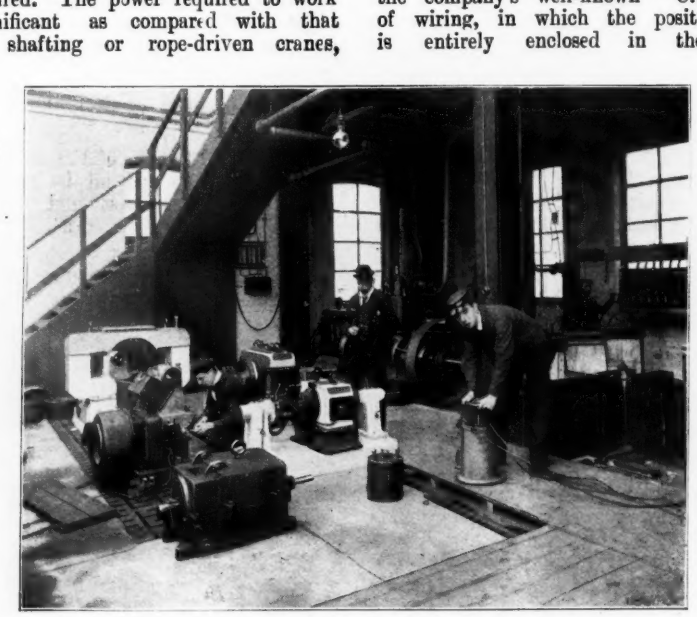
after one day's instruction can readily handle the crane, and expertness is soon acquired. The power required to work this crane is insignificant as compared with that required for square shafting or rope-driven cranes, and the power is only absorbed for actual work; there are no "stand-by" losses. The electric current is carried to the crane by a No. 4 copper wire, supported on insulators attached to the main girder on the east side of the shop. A rubbing contact attached to the cage picks up the current from this conductor, whence it is led by cables to the controlling switches. The crane girders themselves are fitted with conductors for carrying the current to the hoisting and across traverse motors, the current being picked up by rubbing contacts on the crab. The long traverse is driven by a light spur gear, and the cross and hoisting by special wormgears running in oil boxes.

Entering from the fitting shop is the smithy and boiler-house. In the smithy is fitted one 3-cwt. steam hammer and three forges, the forge blower being driven by an electric motor.

The brass shop occupies the ground floor of the portion of the building facing King Street. It is fitted out with turret lathes, milling machines, multiple drills, &c., for the production of large quantities of brasswork for use on switchboards, and on the various appliances connected with the wiring and installation of electric light and power. In this department, as in the machinery shop, advantage has been largely taken of the most modern improvements in American machine design, and the result is an immense improvement in the economy and accuracy of the product.

The winding shop is accomodated in the same building as the brass shop, but on the upper floor. Into this department are delivered the armature cores and magnet formers to be wound with copper conductors. There is little machinery in this department, the greater part of the work being performed by hand. The magnet wire is wound on the formers on a group of lathes driven by an electric motor. A light overhead travelling crane, operated by hand, is provided for handling parts in process of manufacture. It is capable of lifting two tons, and sweeps the whole length of the shop. After completion of the winding the armatures and magnet coils are lodged in a drying stove until the moisture is thoroughly expelled from the insulating materials. This stove is situated over specially constructed flues between the main boilers and the chimney.

In the machine shop are also placed the steam boilers, engines and dynamos for the production of electric current for lighting the works and driving the machinery. The electric lighting installation for the works and offices consists of 230 16-C.P. lamps, 30 Sunbeam 150-C.P. lamps, and six arc lamps of 2,000-C.P. each. There are in all 15 motors, of 85 aggregate horse-power. Two boilers generate steam at 160 lbs. pressure. The smaller boiler is just capable of overtaking the present work, but a Babcock & Wilcox boiler, evaporating 2,280 lbs. of water per hour, has been recently added to provide for extensions. The electric current is generated by two dynamos, each mounted on the same bedplate with and coupled direct to a high speed single acting engine. The output of each combined set is 40 electrical horse-power. From the steam dynamos the conductors are led to the main switchboard, from which point the whole of the distribution is carried out on the company's well-known "C.C." Concentric System of wiring, in which the positive or live conductor is entirely enclosed in the negative conductor, which is uninsulated and connected to "earth." The lighting and power are supplied from the same system, but on different circuits. Each circuit is controlled by a switch on the main switchboard, on which are also placed ammeters and voltmeters to indicate the amount of power being used at any instant. Adjoining the steam dynamos is the testing table, on which all machines are temporarily run before being despatched.



Test Room.

In the brass foundry, which forms another department, are made all the brass and a few light iron castings required for the various manufactures carried out in the works. It is provided with six moulding furnaces and a core drying oven. For cleaning and cutting off the castings a group of cutting-off saws, emery grinders, and scratch brushes are driven by a 4½ horse-power electric motor, coupled direct to a short counter-shaft. A "Cyclone" dust collector with fan driven by a motor is arranged to draw the dust from the emery grinders and deposit it in a receiver. The men are thus saved from breathing the metallic particles, and the metal is saved for re-melting. Plate moulding has been recently introduced to this department with very successful results.

While the excellence of the manufactures has secured for the company a large share of English and foreign work, and important contracts for Government departments, municipalities, and public bodies, the directors, in the design and equipment of the new factory, have kept prominently in view the large and increasing demand for electric machinery, especially for power purposes, in this district. The directors believe that there is no more promising field in the whole world for the introduction of the applications of electricity to industrial purposes than that embraced by a circle of 10 miles' radius round the city of Glasgow, and they are of opinion that the existence of these works in Glasgow will give an important stimulus to the adoption of electrical plant in Scottish industries.

THE RELATIONS BETWEEN CUSTOMER, ENGINEER AND MANUFACTURER.

In continuation of this subject, on which we published a leading article in our issue of February 11th, Mr. S. Dana Greene considers the tests and guarantees prescribed in specifications. Tests may be classed under the few heads of efficiency, heating, regulation, sparking, and insulation—he is speaking, of course, of electrical machinery particularly, and is of opinion that there should be standard tests which would simplify matters all round. Such uniform tests, moreover, would place a consulting engineer in a very strong position, for his duty would simply be to see a certain standard worked up to, and he would not then be exposed to the possibility of having to withdraw or alter unworkable clauses of his own drawing up. He advises, for America, that such standards should be drawn up by the Institute of Electrical Engineers, and why should not the same duty be undertaken by the English Institute for England. Frequently there are misconceptions as to the proper definition of efficiency—commercial or electrical. The former alone interests the customer, and for want of the proper understanding of this, we may see huge extravagancies in all sorts of practice.

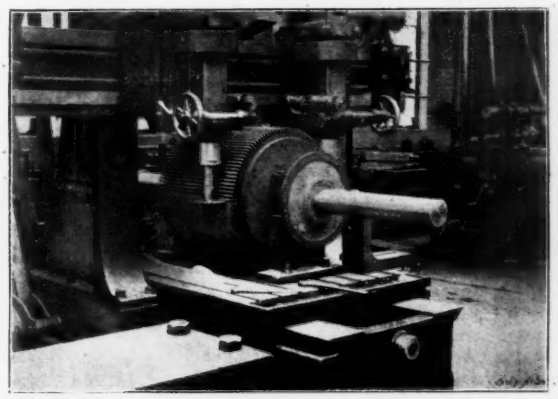
Thus, as recently pointed out by Mr. Raworth, the pursuit of the item of small fuel consumption per I.H.P. may have caused Lancashire mill owners to overlook an economy of first cost which would have been better appreciated if brake horse-power had been the datum line.

All electrical manufacturers have their own figures for the difference between carbon and copper brushes in efficiency and between different voltages, and so on, and it ought not to be difficult to form intelligent general rules.

Mr. Greene objects to the demand made upon the electrical manufacturer to guarantee the combined efficiency of engine and dynamo. Overload guarantees are sometimes required, ranging from 25 to 100 per cent. This often means increasing the capacity of a machine as surely as if it had been asked for in the specifications. Unreasonable demands for overload amount to an attempt to buy big machines at the price of small ones.

Impossible demands often specified are the straight line compounding curve, practically unattainable until we discover a magnetic material with a straight line saturation curve and a drop of 2 per cent. in speed of lighting generators not to affect the E.M.F. more than 2 volts, also impossible even with separate exciting.

In testing for insulation, because a 5,000-volt test is correct for a 1,000-volt machine, it does not follow that a 10,000-volt machine should be tested to 50,000 volts. The proper method is to consider jointly the duration of test, current frequency, and voltage. As the latter rises, the margin between it and the test voltage necessarily decreases, because of the risk of injury to insulation from excessive voltage. All these things might properly be standardised, and excessively drawn specifications, leading to distorted designs and special apparatus, put a load on the customer's purse in the long run, for manufacturers do not for ever work at a loss, and the eccentric engineer becomes shunned by the best manufacturers, and is generally looked on with suspicion.



Mavor & Coulson's.—Duplex Milling Machine Slotting Armature Cores.

Mavor & Coulson's.—Armature Winding Shops.

Often a contractor, working for a penalty date, and paying expensive overtime, finds himself with the stuff on his hands for weeks after it should have been paid for. This sort of thing is very unfair. It is bad for workmen who have been pushing a job, to see their finished work lying ready for shipment for weeks. They invariably let the fact influence them when the next push job comes to hand, and the demoralisation perhaps makes a really urgent job late. Where there is a penalty for delay, it is urged there should be a bonus for prompt readiness to date. Again, the self-appointment of a consulting engineer as sole judge, is considered unfair; and though probably it could not be enforced at law, there ought to be provision for a third party.

Generally, Mr. Greene's paper was suggestive, and met the cordial approval of his hearers, who invite the American Institute of Electrical Engineers to consider some comprehensive plan for such standardisation of apparatus for electric light and power.

Writing on the other side of the question from that taken by Mr. Greene, Mr. White-Fraser looks on the consulting

engineer as a safeguard to the honourable manufacturer—protecting him from the unscrupulous maker of inferior goods. Mr. Fraser also rather deprecates standardising as likely to hinder engineering progress. But Mr. Fraser writes as though Mr. Greene had asked for the abolition of the consulting engineer, for he refers to alternate and direct current machinery, and the pushing of one or the other by the manufacturer, where the consulting engineer would, unbiassed, be able to advise which was the better system. But Mr. Greene did not wish to abolish the engineer so much as to curb him, and restrain the tendency to design new plant when equally good things are to be bought in open market. It is in selecting systems that the value of the consultant should come in; in giving out orders that his knowledge of manufacturers should prove valuable; in passing work as sound, that his technical knowledge should avail him. There is indeed plenty for him to do in applying his knowledge and making general arrangements. As we write these lines we have in mind a large pair of steam engines which, though only performing an ordinary factory duty, were built from entirely new patterns to a design got out in a consulting engineer's office. They are wasteful and extravagant, and probably cost over double what any good firm of engine builders would have charged for far better designs of standard type. Americans are well to the fore in many respects in this matter of standards. Parts of railroad cars are standardised, and we don't know that this fact has done much to prevent progress and change along proper lines of development. We have no such progress-stopping standards on English railroads, yet who will deny that there are vehicles running on the South-Eastern Railway that are of the type of 50 years ago, if not themselves 50 years old? Americans have tried to standardise cement tests. Here every little architect or engineer who calls for the use of a bag of Portland cement must write out a wordy specification for a product of which he has no technical knowledge. Yet every one knows that Portland cement could be standardised under three classes—some men would say one class would cover everything—and might be classed as A, B, or C, and so specified. The question for the consulting engineer himself to determine is how far he is to carry out his own personal supervision. There is a point somewhere between a mere outline of a building and a specification and drawing of the floor brads, at which an architect has to draw the line. It is only a question of degree, and how far we are to go in the direction of designing our own details. In Mr. Fraser's opinion the chief objectors to consulting engineers are the manufacturers of everything; the special manufacturers who make one thing, and that perfect, look on him as a friend. They ought to be able to do so, if only he will do his duty as a selective agent.

Mavor & Coulson's: Machine Shop, West Bay.

In further correspondence on this subject, a Mr. F. J. Johnston implies that consulting engineers have been, at times, poorly informed men. He instances where one electrical engineer in a responsible position sent a flagman to a distance of 1,000 or 1,500 feet with a flag which he was to drop on receiving an electrical signal at a device placed by him. The engineer pressed the button and timed between the pressing of the button and the fall of the flag. The idea of the test was to *determine how long the current required to travel the 1,000 or 1,500 feet!!!*

Mr. Johnston points out that customers select their engineers and place them to overlook contractors, yet customers are no more competent to select engineers than the ordinary layman is competent to select a specialist physician.

Generally, there seems to be an opinion abroad that contractors are very much in the hands of engineers who arrogate to themselves the sole right of judging questions of materials and workmanship, and have the power to hinder work and to throw all kinds of expensive delays in the way

of the contractor for which he can make no charge. In fact, the contractor is looked upon as though he were making a huge fortune and is expected to stand all manner of extortion. If engineers will be so extravagant in the demands they make for recognition, they might at least be fair enough to protect the contractor from robbery. Engineers are occasionally far too apt to give ear to any tittle tattle which brings them lying reports of bad work. Such are the views of contractors; to the other side we may next give attention.

CONTRACTS OPEN AND CLOSED.

OPEN.

(*Continued from page* 404.)

Spain.—March 29th. Tenders are being invited by the municipal authorities of the town of Zafra (Badajoz province) for the concession for the electric lighting of the public streets during a period of 20 years. Particulars and conditions may be obtained from, and tenders to be sent to, El Secretario del Ayuntamiento de Zafra (Badajoz), Spain.

Switzerland.—April 30th. Plans and estimates are being invited, says the *Contract Recorder*, by the Government authorities of Fribourg, Switzerland, until April 30th next, for a projected electricity generating station to be established at Hauterine. Water-power is to be utilised, and the station will have a capacity of about 6,000 H.P. A premium of £120 will be awarded to the three schemes submitted which are considered to be the best. Plans and estimates are to be sent to the Department des Travaux Publics, Fribourg, Switzerland, from whence full particulars of the competition may be obtained.

The War Office.—April 27th. The Secretary of State for War is prepared to receive offers, competitive designs and specifications for the supply of portable electric search light apparatus. Particulars from the Director of Army Contracts, War Office, Pall Mall, S.W. See our "Official Notices" February 4th.

Victoria.—June 24th. The Council of the city of Hawthorne (Colony of Victoria, Australia) is inviting tenders for the supply and erection of buildings, boilers, engines, dynamos, transformers, mains, meters, arc lamps, poles; also running the plant for three years. See our "Official Notices" March 11th.

CLOSED.

Glasgow.—On 17th inst. the Corporation adopted the recommendations of the Electricity Committee accepting the following offers:—(1) The offer by Messrs. Laing, Wharton & Down, for one engine and dynamo of 700 horse-power at the price of £5,064; (2) the offer by Messrs. Mirrlees, Watson & Yaryan Company, Limited, for one engine and dynamo of 400 horse-power at the price of £1,970; (3) the offer by Messrs. Mavor & Coulson for one engine and dynamo of 900 horse power at the price of £5,775; and (4) the offer by Messrs. Mirrlees, Watson & Yaryan Company, Limited, for one engine and dynamo of 200 horse-power at the price of £1,265. An offer obtained from Messrs. Babcock & Wilcox, Limited, to provide and erect at the new generating station, Port Dundas, two of their patent boilers of about 1,000 horse-power each, with relative superheaters, at the price of £2,020 for both boilers and superheaters was also accepted. Bailie Maclay, in moving the minutes, explained that the engines, dynamos and boilers, contracts for which were thus recommended, represented 2,200 horse-power. They took it that these engineers were bound to deliver the plant by a certain date, somewhere about the end of August. They hoped to have the new works in operation immediately thereafter, and in that way they would be ready to supply current from their two works against the increased demand of next winter. There was urgency in the case, and they were going ahead with the business as quickly as possible. All the engines are Scotch, with the exception of one, which is American.

Salford.—The following is a list of the firms who tendered for the supply of electric cables for the Corporation:—The British Insulated Wire Company (high tension); The Callender Cable and Construction Company, Limited; The Western Electric Company; W. T. Glover & Co. (low tension); W. T. Henley's Telegraph Works Company; Siemens Bros. & Co. The tenders of the British Insulated Wire Company and Messrs. W. T. Glover & Co. were accepted.

West Derby (Lancs.).—For the electric lighting of the Mill Road Infirmary the Board of Guardians have, according to *Daily Tenders and Contracts*, accepted the tenders of the following:—

Boilers.—Messrs. Fawcett, Preston & Co., Liverpool	£1,075
Engine House Plant.—Messrs. Scott, Anderson & Belt, Sheffield	2,085
Batteries.—The Chloride Electrical Storage Syndicate, Manchester	440
Wiring Buildings.—Messrs. W. & J. Robinson, Limited, Bootle	1,411

Mr. T. L. Miller, M.I.E.E., is consulting engineer.

GLASGOW TELEPHONE INQUIRY.

The report of Sheriff Jameson is an example of the disadvantage of government by commission and of the proverbial infelicity of giving reasons for decisions.

The delay in the publication of the report after the taking of the evidence, though considerable, is not so great as to necessitate here a recapitulation of the circumstances under which Sheriff Jameson's inquiry was undertaken. Upon the evidence submitted to him, he finds that the telephone system in Glasgow is not efficient, the inefficiency being mainly due to the refusal by the Corporation of underground facilities to the Telephone Company, but he thinks that the company's service might be improved by a more thorough supervision of the switch room and other improvements; he is more than usually emphatic in expressing his opinion that the comparisons which were introduced with a view to showing that the company's charges were excessive, are altogether outside the circumstances of the case. With regard to the license, he gives reasons for recommending that a license be not given to the Corporation, whilst, in the concluding paragraphs, he suggests that, notwithstanding all the objections he has pointed out, the license should be granted to the Corporation, "throwing on them the whole responsibility of their proposed undertaking," if the Post Office does not itself start a telephone exchange, and provided the Corporation is able to satisfy the Postmaster-General that financially its scheme is sound, and that it has the means of carrying it out.

In forwarding the report the Secretary to the Post Office states that the Postmaster-General is precluded from assenting to the wishes of the Corporation by issuing a license, because in the present state of the law the Corporation has no power to carry on the business of a telephone exchange. Sir J. D. Marwick, the town clerk of Glasgow, in acknowledging Mr. Walpole's letter, takes advantage of the fact that His Grace the Duke of Norfolk "has been so good as to indicate the grounds on which he has arrived at his opinion," and discusses them in some detail, finally concluding with the intimation that if the Post Office will give them a license, they will take the necessary steps to obtain the legal powers.

Thus it will be seen that instead of the question being finally settled upon grounds of public policy, it has been settled in such a way as to invite further argument and agitation. Sheriff Jameson was, doubtless, under the impression that throwing the whole responsibility of their proposed undertaking on the Corporation might act as some deterrent, but the nature of the evidence brought before him should have sufficed to show that the advocates of a municipal service are either insufficiently acquainted with the responsibility, or are willing to undertake any sort of risk with a view to adding a telephone service to their other enterprises. We have on so many occasions pointed out that the decision on telephonic policy must be come to by those who have had proper opportunities for studying the question, and some responsibility in the settlement of it, that we need now only point out how the decision in this case has finally rested with the Post Office. Efforts will undoubtedly be made either to over-ride this decision, or to impugn the motives underlying it. It is certainly to be hoped that neither the Treasury nor Parliament will be coerced or cajoled into removing the decision from the hands of those who have knowledge and a sense of responsibility—the two essential elements needed for a decision on this important question.

Ceylon Technical College.—An Indian paper says that the staff of the Ceylon Technical College has been strengthened by the addition of Mr. Thomas Cockerill, who takes up the post of Instructor of Telegraphy and Electrical Engineering. Mr. Thomas Cockerill, who recently went out to India from this country, is a Fellow of the Chemical Society and an A.I.E.E. He was trained at Owen's College, Manchester, and at the Manchester Technical School. He was lecturer and head of the Electrical Departments at the Bolton Technical Schools and at the Halifax Technical Schools.

NOTES.

Obituary.—It is with great regret that we have to chronicle the death of Col. Dyer, which took place on the 21st inst. at his residence in Manchester. We fear that the arduous and anxious time passed through by him during the recent long strike must have been largely accountable for the accentuation of the organic trouble of the heart which seems to have finally caused his death. As head of the Employers' Federation, he was in the forefront of the battle, and the credit of victory is largely with him, and his sudden death will come as a great blow to the Federation. The incidents and causes of the strike are too fresh for comment to be necessary, but we believe all admit that he was animated by a desire for his country's welfare, and in no way can he be accused of harshness in his dealings with the conquered, whose defeat was, after all, much better for themselves than a victory could have been. Colonel H. C. S. Dyer was a director of Sir W. G. Armstrong, Whitworth and Co., Limited. He joined the Royal Artillery at the age of 18, and saw active service in the Crimea and in India. On retirement as lieutenant-colonel he became assistant superintendent of the Enfield Factory, whence he transferred to Sir Joseph Whitworth, of Manchester, and subsequently to the Elswick Works, which he was instrumental in amalgamating with those of Whitworth, knowing the two places so well. The colonel was of fine and commanding appearance, and in losing him England has lost a representative man of the best type of national character. Born in 1834, he has died at what is now the very early age of 64.

The funeral, which took place on Wednesday at Manchester, was an imposing ceremony, the carriages forming a line more than a mile in length. A large number of the members of the Employers' Federation assembled in the drawing room at Appleby Lodge, Rusholme, the residence of the deceased gentleman. These included Sir Benjamin Browne, Mr. Henderson, Mr. Platt, Mr. Coventry, Mr. Brooks, Mr. Browett, Mr. Alexander Siemens, Mr. Lindley, Col. Peacock, Mr. Sinclair Scott, Mr. Slater Lewis, Mr. Baldwin, Mr. Eddison, and many other gentlemen who took an active part with Col. Dyer in the recent dispute. The utmost sympathy was expressed on all sides, and there was a general feeling that the master engineers had been bereft of a brave and able champion of their cause in the loss of Col. Dyer.

The last issue to hand of Chicago *Electrical Engineering* has a long obituary notice of the late Dr. V. Weitlisbach, who died in November, 1897, in his 43rd year. Dr. Weitlisbach was born in Switzerland, and in the seventies studied under Helmholtz at Berlin. He was manager of the Zurich Telephone Company from 1880 to 1884, and was then appointed chief engineer to the Swiss Telegraph Administration in Berne, under the title of first secretary to the Technical Department. That position he held at the time of his death. Telephone work claimed Dr. Wietlisbach more than anything else, and he has been a frequent contributor to the Berlin and Berne technical press on telephone questions. Dr. Weitlisbach had, at the time of his decease, nearly completed a large and thorough treatise on telephony.

Lectures.—Mr. J. E. L. Barnes lectured at the Birkenhead Town Hall on 16th inst. on "Electric Traction."

Before the Aberdeen Mechanical Society at Gordon's College, on the 18th inst., Mr. Wm. Pickersgill, G.N.S.R. locomotive superintendent, read a paper on "The Economic Use of Electricity for Power Purposes in Railway Workshops."

Mr. Roger W. Wallace, Q.C., chairman of the British Aluminium Company, read a paper before the Society of Chemical Industry on 14th inst. on "Electrical Industries at Foyers."

At the Birmingham Municipal Technical School Engineering Society last week a paper on "The Making and Laying of an Atlantic Cable," was read by Mr. William Smith, the electrical engineer of the Technical School.

At the Royal Scottish Society of Arts meeting on 14th inst. Dr. Redman, F.R.S.E., read a paper on "The Electric Furnace, and Some of Its Uses."

Magnetism and Diamagnetism.—Prof. J. A. Fleming, F.R.S., gave the third of his course of lectures on "Recent Researches in Magnetism and Diamagnetism," at the Royal Institution on Thursday last week, the special subject being the properties of the diamagnetic group of bodies. An experiment was first shown, says the *Times* report, illustrating a method employed by Quincke for measuring the magnetic susceptibility of paramagnetic and diamagnetic liquids. An inverted syphon containing the liquid to be tested, and having one leg much thinner than the other, had its narrow tube placed between the poles of a magnet, when the liquid, if paramagnetic, was drawn up into the field, and if diamagnetic, depressed in the tube. Numerous experiments were then performed with a large electro-magnet, constructed for Tyndall, to show that paramagnetic bodies held in the interpolar field set themselves along the lines of force, whereas diamagnetic ones placed themselves across in the equatorial position. Illustrating Faraday's observation that all substances were affected in one way or the other by a powerful magnetic field, Prof. Fleming caused some amusement by showing that such familiar objects as bread, apple, cold mutton, and tobacco were acted upon by a strong magnet. The influence of the medium surrounding a substance in determining its action in the field was demonstrated by means of other interesting experiments. The peculiar behaviour of crystals called by Faraday magnecrystallic action was then explained, and attention was called to Tyndall's important investigations, during which he discovered that structural changes such as those produced by compressing a substance in any direction greatly affected its magnetic susceptibilities. This fact was demonstrated by means of a piece of bread, which, although diamagnetic, simulated the behaviour of a paramagnetic body after being squeezed, because the line of compression became an axis of greater diamagnetic action. Turning to the action of diamagnetic bodies on light, the lecturer exhibited Faraday's classical experiment, in which a block of magnetised heavy glass (silico-borate of lead) was proved to rotate the plane of a polarised light, and concluded with a reference to the more recent work of Verdet, Kundt and others on magneto-optic effects.

Ward's Omnibus Tests.—There are apparently some errors in the volt readings in the report of these tests, from the 55th minute to the 65th. Amperes 32 and volts 224 may be right; but at the 65th minute, while still 32 amperes, the volts are given 244. Either one or the other must be wrong. At the 95th minute we notice a reading of 40 amperes and 216 volts, and the last reading is 40 amperes and 220 volts. If these figures were correctly noted, it would seem that the battery must have been charging up during the last 10 minutes! The difficulties in reading instruments on board an omnibus may account for a good deal, and the figures can only be taken as a rough approximation, near enough to obtain an idea of the power required. It would be interesting to try how many bus horses would haul that bus home if the battery ran down.

Personal.—We are informed that on February 9th, 1898, Lord Salisbury appointed Mr. Geo. Herbert Bailey Assistant District Commissioner in the Niger Coast Protectorate by telegram. Besides his judicial duties, no doubt when the state of the country under the sphere of influence involved renders it practicable, advantage will be taken of Mr. Bailey's experience of matters telegraphic in connecting up the capital of the Protectorate (Old Calabar) with the African cable system and the establishment of inland telegraphs.

Mr. Lycett is resigning the position of clerk to the Kingswinford Rural District Council, and has become district manager to the British Electric Traction Company.

Mr. R. S. Portheim, of Messrs. D. Bruce Peebles & Co., engineers, of Edinburgh, is sailing for the States on the 26th inst. per ss. *St. Louis*, and will investigate the latest American practice in electric transmission of power.

Will.—The estate of Lord Sackville A. Cecil, whose connection with the telegraph world we referred to in our notice of his lordship's death, is sworn at £249,388.

Municipal Electrical Association.—At a meeting of the Council of the Municipal Electrical Association held at the Westminster Palace Hotel, London, on March 15th, it was resolved to call a general meeting of the Association to be held at the Westminster Palace Hotel, London, on April 19th, at 8 p.m. The following applications for membership were considered and approved. Members:—W. H. Chambers, Gibraltar; C. F. Parkinson, Morecambe; J. K. Brydges, Wakefield; the E. L. Committee, Barrow-in-Furness; the E. L. Committee, Darwen; Stanley Clegg, Darwen. Associates:—S. E. Andrew, Leytonstone; J. C. Vaughan, Leytonstone; T. D. Clothier, Hull; A. N. Puszet, Brighton; N. McLean, Harrogate.

Royal Institution.—The Friday evening lecture arrangements for after Easter include the following:—April 29th, Prof. Andrew Gray, M.A., LL.D., F.R.S., "Magneto-Optic Rotation and its Explanation by a Gyrostatic Medium," (with experimental illustrations). May 6th, Edward A. Minchin, Esq., M.A., Fellow of Merton College, Oxford, "Living Crystals." May 13th, Prof. W. A. Tilden, D.Sc., F.R.S., "Recent Experiments on Certain of the Chemical Elements in Relation to Heat."

Prof. Dewar will deliver the weekly discourse on April 1st. His subject is "Liquid Air as an Analytic Agent."

The Northampton Institute.—Great men are, like the *Daily Mail*, often in advance of the Times, so was last week's *Engineering*. We were under the impression that the Lord Mayor's state visit to the Northampton Institute—to which we refer at length in another column—took place last Friday evening. Our contemporary, however, says the ceremony occurred on the Wednesday previous, so that we and the 2,000 or more who were present on Friday—including the Lord Mayor and Lady Mayoress—arrived just 48 hours behind time!

Technical Education.—The presentation of certificates to art, science and domestic economy scholars, under the Technical Education Board of the London County Council, was made by the Right Hon. Sir Bernhard Samuelson, Bart, F.R.S., at the Northampton Institute, St. John Street Road, E.C., last night.

The Successor of Prof. Galileo Ferraris.—An American exchange says that Prof. Luigi Lombardi has been appointed Professor of Technical Physics at the Industrial Museum of Turin to fill the chair which was left vacant by the death of Prof. Galileo Ferraris.

Mechanical Engineering in Germany.—It is stated by H.M. Ambassador at Berlin that no further applications for admission to the Mechanical Engineering Department of the Technical High School at Charlottenburg, near Berlin, can be received after April 1st next from persons not of German nationality, as the increase of students in that department has been so great that the accommodation is overtaxed.

Damages Awarded.—At the Brompton County Court on Monday, Mr. John Price, an excavator for the new Central London Electric Railway, was awarded, by agreement, £300 and costs, under the Employers' Liability Act. In November last a heavy quantity of earth fell on him, causing motor paralysis of both legs.

Appointment Vacant.—The British Electric Traction Company, Limited, is wanting an electrical engineer to design and construct power houses, and to undertake the electrical equipment of tramways, including rolling stock, but not permanent way. See our "Official Notices" this week.

The Wonders of the Telegraph.—The following marvellous instance of what the electric telegraph is now capable of doing appeared in yesterday's *Standard*:—

HARDING.—On March 19th, at Chefoo, China, the wife of John Reginald Harding, M.I.C.E., of a son. (By telegram).

Private Bills.—The General Power Distributing Company Bill, Central Electric Supply Bill, Chelsea Electricity Supply Bill, and the Metropolitan Electric Supply Bill passed the second reading on Tuesday.

West Ham Wiring Tenders.—Messrs. Allingham and Fennell say that in a published list of tenders for the wiring of the public buildings at West Ham their name is omitted, although a tender was submitted by them for carrying out the work on their "Nomorfyre" system for the sum of £1,139 15s. The town clerk informs them that their tender is being considered with the others.

The Parliamentary Committee.—The House of Commons representatives on the joint committee on electrical energy, generating stations and supply, are Mr. Ashton, Lord Balcarres, Mr. Kimber, and Sir Leonard Lyell.

The Electro-Harmonic Society.—To-night's Concert brings the 1897-98 season of this Society to a close, and it will be pleasant to see a large gathering of members and friends. Classical chamber music is worthily represented by Haydn and Schubert, while piano and violin solos will be represented by compositions of Chopin and Vieuxtemps. Mr. James Gawthrop and Mr. Robert Hilton, whom everybody will be pleased to see again, will sing ballads. The humorous element will be supplied by Mr. W. G. Churcher, and Mr. W. Carlton Smith, and the small string orchestra, which has added so much to the enjoyment of these monthly meetings, will again discourse sweet sounds.

Torquay Municipal Lighting.—The municipal electricity works were formally inaugurated last Friday by the Mayoress of Torquay. In a subsequent issue we shall describe the principal features of the system.

NEW COMPANIES REGISTERED.

London and District Mutoscope Company, Limited (56,367).—Registered March 4th with capital £75,000 in £1 shares, to adopt an agreement with the Mutoscope and Biograph Syndicate, Limited, for the acquisition of a license to use certain patents, to manufacture, sell and deal in mutoscopes, biographs, photographic apparatus, and to carry on the business of electricians, and electrical and mechanical, metallurgical and chemical engineers. The subscribers (with one share each) are:—E. Baker, 29, Cornhill, E.C., secretary; M. J. M. Campbell, Orleans Club, King's Street, W., gentleman; E. J. Nicholas, 29, Cornhill, E.C., secretary; W. Johnson, 8, Shalcombe Street, Chelsea, S.W., clerk; G. Beeson, 2, Clarendon Terrace, W., clerk; S. E. Newman, 72, Romilly Road, Finsbury Park, N., clerk; R. Humphreys, 23, Digby Road, South Hackney, N.E., clerk. The number of directors is not to be less than two nor more than seven. The subscribers are to appoint the first. Qualification, 100 shares; remuneration, £1,000 per annum, and a percentage of the profits divisible. Registered office, 29, Cornhill, E.C.

Phœbus Solder and Electric Soldering Fluid Company, Limited (56,373).—Registered March 4th with capital £4,000 in £1 shares, to acquire and carry on the business of solder, soldering fluid and alloy manufacturers carried on as the "Phœbus Solder and Electric Fluid Company" at 5, York Grove, Peckham, S.E. The subscribers (with one share each) are:—E. E. Bailey, 69, Kilmoirie Road, Forest Hill, S.E., engineer; L. C. J. Graper, 3, Harman Street, Kingsland, N., traveller; J. R. Woodley, Hopton Road, Streatham, S.W., accountant; H. H. Champness, 42, Huddlestone Road, Tufnell Park, N., gentleman; C. G. Cheverton, 43, Breakspears Road, St. Johns, S.E., gentleman; A. H. White, 26, Rosenthal Road, Catford, stockjobber; F. D. Sandell, 12, Ravensbourne Road, Catford, accountant. Table "A" mainly applies. Registered office, 5, York Grove, Queen's Road, Peckham, S.E.

Electric Lighting and Fittings Corporation, Limited (56,379).—Registered March 5th with capital £50,000 in £1 shares to carry on the business of electrical and mechanical engineers, and manufacturers of and dealers in electric, magnetic, telegraphic, telephonic, and other appliances, and steam, hydraulic, pneumatic, and other engines. The subscribers (with one share each) are:—A. Cross, 2, Balliol Road, Bootle, timber merchant; J. A. Dargue, C.E., 175, Bedford Street, Liverpool; J. B. Hepburn, 21, Brasenose Road, Liverpool, engineer; L. Hughes, 23/31, Hatton Garden, Liverpool, merchant; T. H. W. Walker, 41, North John Street, Liverpool, architect; H. Isaac, 23, Great Charlotte Street, Liverpool, fishmonger; C. Birchall, Egremont, Chester, shipowner. The number of directors is not to be less than three nor more than seven; the first are the first five subscribers; qualification, £200; remuneration as fixed by the company. Registered by Cameron, Kemm & Co., Gresham House, E.C.

Best & Lloyd, Limited (56,397).—Registered March 8th with capital £50,000 in £10 shares, to acquire and carry on (1) the business of a manufacturer of, and dealer in, chandeliers and electric and gas fittings carried on by R H. Best, at Handsworth, Staffordshire, as "Best and Lloyd," and (2) the business of a manufacturer of and dealer in red lead carried on by R. H. Best at Handsworth, Staffordshire, as "J. and H. Lloyd," and to adopt two agreements with the said vendor. The subscribers (with one share each) are:—R. H. Best, Cambray Works, Handsworth, manufacturer; W. R. Nicholl, Northleigh, Olton, near Birmingham, accountant; J. Pinckston, Stowe Villa, Albert Street, Handsworth, manager; G. Vale, Lauriston, Rookery Road, Handsworth, manager; Miss E. H. Best, 23, Radnor Road, Handsworth; Miss L. H. Best, 23, Radnor Road, Handsworth; Mrs. E. M. Best, 146, Hamstead Road, Handsworth. The number of directors is not to be less than three nor more than five; the first are R. H. Best (chairman, with £1,000 per annum); W. R. Nicholl, G. Vale and J. Pinckston; qualification, 50 shares; remuneration, £100 per annum. Registered by Waterlow Bros. & Layton, Limited, Birchin Lane, E C.

British Electric Meter Company, Limited (56,408).—Registered March 8th with capital £5,000 in £10 shares, to acquire and turn to account a sole selling agency and an option for an exclusive manufacturing license in the Bastian electrolytic meter, and prepayment attachment, and to adopt an agreement with the Tourtel Gas and General Engineering Company, Limited. The subscribers (with one share each) are:—A. V. Askham, 41, Clifford Gardens, Kensal Rise, W., secretary; J. M. Tourtel, 35, St. Luke's Road, Westbourne Park, W., gentleman; C. E. Smith, 1, Wedmore Gardens, Upper Holloway, foreman; J. B. Birnbaum, 2, Long Acre, W.C., merchant; A. Laurmon, 39, Westbourne Street, Sloane Square, S.W., clerk; O. G. Peterson, 82, Weed Vale, Forest Hill, S.E., clerk; W. H. Carlisle, 54, Margravine Gardens, West Kensington, clerk. The number of directors is not to be less than two, nor more than five. The first are: A. F. Davies and J. M. Tourtel. Remuneration, two guineas each per board meeting attended. Registered by Devonshire & Co., 1, Frederick's Place, Old Jewry, E.C.

Costa Rica Electric Light and Traction Company, Limited (56,447).—Registered March 10th with capital £130,000 in £1 shares, to adopt an agreement with M. C. Keith to carry on the business of electric lighting in the Republic of Costa Rica or elsewhere, and to carry on the business of tramway and light railway proprietors, common carriers, electricians, mechanical engineers, &c. The subscribers (with one share each) are:—R. Killman, 14, Sunnyside Road, Ilford, accountant: T. S. Cocks, 71, College Street, Putney, clerk; F. Chipperfield, 179, Choumert Road, Peckham, S.E., clerk; J. C. Holliday, 9, New Broad Street, E.C., clerk; F. H. Firth, Copthall, Twickenham, gentleman; H. W. White, Sydney House, Barrow Road, Streatham, clerk; W. H. Avery, Clareville, Sutton, secretary. The number of directors is not to be less than three nor more than seven; the subscribers are to appoint the first. Qualification, £250; remuneration, £150 each per annum, and £200 for the chairman. Registered by Ashurst & Co., 17, Throgmorton Avenue, E.C.

Premier Electricity Meter Company, Limited (56,448).—Registered March 10th with capital £25,000 in £5 shares, to carry on the business of electric meter manufacturers and dealers, and electricians. The subscribers (with one share each) are:—J. Atherton, 11, Charing Cross Road, W.C., manufacturer: C. M. Downie, 24, Newman Street, Oxford Street, W., electrical engineer; J. Downs, 8, Marlborough Villas, Wimbledon, clerk; W. M. M. Forwood, 15, Union Court, Spl., solicitor; C. O. Grindrod, 11, Knowsley Road, Rock Ferry, Cheshire, gentleman; A. E. Haptie, 5, Durham Road, Seaforth, near Spl., cashier; A. Ruckley, 8, York Road, Seacombe, Cheshire, clerk. The number of directors is not to be less than three nor more than seven. The subscribers are to appoint the first. Qualifications, £100; remuneration as fixed by the company. Registered by T. T. Hull, 22, Chancery Lane, W.C.

Shirras, Laing & Co., Limited (3,793).—Registered at Edinburgh March 10th with capital £30,000 in £1 shares, to acquire the business of Shirras, Laing & Co., ironmongers, blacksmiths, electrical and heating engineers, 46—52, School Hill and Harriet Street, and Back Wynd, Aberdeen, and to carry on and develop the same. The subscribers are:—J. Murray, 28, St. Nicholas Street, Aberdeen, publisher, 300 shares; D. Smith, 27, Argyll Place, Aberdeen, farmer, 400 shares; J. Taggart, 92, Great Western Road, Aberdeen, granite merchant, 200 shares; H. Mortimer, 143, Union Street, Aberdeen, solicitor, 200 shares; G. Shirras, School Hill, Aberdeen, ironmonger, 1,000 shares; R. Haley, School Hill, Aberdeen, ironmonger, 1,000 shares; J. Stephen, 3, Corridean Wynd, Aberdeen, engraver, 250 shares. The directors are to be afterwards appointed. Qualification, 200 shares. Registered by Simpson and Warwick, W.S., 18, Heriot Row, Edinburgh.

Love's Electric Traction Company, Limited (56,471).—Registered March 12th with capital £20,000 in £1 shares to acquire the letters patent for the United Kingdom and various countries other than the U.S.A. and Spain in respect of Love's system of electric traction, to adopt an agreement with J. C. Love and J. E. Hodges, and to carry on the business of electrical and general engineers, machinery manufacturers, tramway and railway proprietors and suppliers of electricity. The subscribers (with one share each) are:—P. W. Goldring, 20, Abchurch Lane, E.C., law student; W. E. Elmslie, 20, Abchurch Lane, E.C., solicitor; H. J. Church, 15, Bendrell Road, Brockley, S.E., clerk; J. Perry, 175, Essex Road, Islington, clerk; J. L. Cooper, 6, Union Road, Tuffnell Park, N., accountant; H. J. Bethell, 128, Beresford Road, Hornsey, N., clerk; A. E. Seamer, 7, Park Place Villas, W., clerk. The number of directors is not to be less than three nor more than seven. The first are:—J. C. Love, J. E. Hodges, W. C. Slaughter, and C. L. Philips; qualification £200; remuneration as fixed by the company. Registered by Goldring & Philips, 20, Abchurch Lane, E.C.

Mid-Air Bulletin Syndicate, Limited (56,507).—Registered March 15th with capital £6,500 in £1 shares, to acquire, own and work certain letters patent granted to S. Crandall, for "improvement in electric signalling and other apparatus," and to adopt a certain agreement. The subscribers (with one share each) are:—F. Brown, Walsall, electrical engineer; J. E. Sheldon, Stafford Street, Birmingham, manufacturer; L. S. Crandall, 62, Moor Street, Birmingham, inventor; W. H. Ryle, 35, Temple Street, Birmingham, land agent; H. A. Pepper, 14, Temple Street, Birmingham, chartered accountant; E. M. Rudland, 14, Temple Street, Birmingham, chartered accountant; J. S. Remington, 97, Castleford Road, Spark Hill, Birmingham, secretary. W. H. Ryle is the first chairman and director. Registered by C. Doubble, 14, Serjeant's Inn, E.C.

Hart Secondary Battery Syndicate, Limited (56,511).—Registered March 15th with capital £5,000 in £1 shares, to adopt an agreement with W. Hart and E. J. Clark, and to carry on the business of electricians, electrical and mechanical engineers, suppliers of electricity, and electrical apparatus manufacturers. The subscribers (with 150 shares each) are:—G. W. Kidd, 229, Romford Road, E., licensed victualler; L. W. Spratt, 369, Romford Road, E., draper; J. G. Locks, Lemna Road, Leytonstone, newspaper proprietor; J. G. Abraham, Craiglands, Stroud Green, surveyor; M. Allcock, 97, Clapton Common, N.E., gentleman; G. Hay, 61, Broadway, Stratford, confectioner; S. W. Hart, Oak Dene, South Woodford, surveyor. Registered, without articles of association, by E. Andrew White, 27, Clement's Lane, E.C.

H. M. Salmony & Co., Limited (56,530).—Registered March 16th with capital £25,000 in £1 shares (5,000 5 per cent. cumulative preference), to acquire the business of H. M. Salmony and Co., to adopt an agreement with H. M. Salmony and E. Rosenberg, and to carry on the business of electrical and mechanical engineers, manufacturers of, and dealers in, electrical apparatus, and contractors for the supply of electricity. The subscribers (with one share each) are:—G. S. Hein, 71, Lombard Street, E.C., bank manager; F. Salmony, 166, Finchley Road, N.W., stock jobber; T. J. Digby, 30, Princess Road, South Norwood, electrical engineer; F. H. Minn, 77, Grange Park Road, Leyton, E., electrical engineer; J. Hart, 69, Linden Gardens, W., electrical engineer; H. M. Salmony, 26, Winchester Road, Swiss Cottage, N.W, electrical engineer; E. Rosenberg, 34, Dryden Chambers, Oxford Street, W., electrical engineer. The number of directors is not to be less than four nor more than six; the first are H. M. Salmony, E. Rosenberg, and H. Schwabe. Qualification, £250 debentures, or £100 shares; remuneration as fixed by the company. Registered by M. Abrahams, Sons and Co., 80, Old Jewry, E.C.

Direct Telephone Exchange Syndicate, Limited (56,542).—Registered March 17th with capital £5,000 in £1 shares, to adopt an agreement with H. Leupold & Vautin, and to carry on the business of a telephone, telegraph, electric light, heat and power supply company. The subscribers (with one share each) are:—P. H. Gardner, 47, Burnam Road, Tollington Park, N., accountant; J. E. T. Wells, 13, Knoyle Street, New Cross, S.E., clerk; J. T. Hayter, 8, Mehetabel Road, Hackney, N.E., writer; C. H. Weeks, 60, Foxham Road, Tufnall Park, N., solicitor; C. Hof, 52, Leadenhall Street, E.C., merchant; B. Steinert, 218, Winchester House, E.C., gentleman; H. Leupold, 20, Grange Road, Norwood, S.E., gentleman. Table "A," mainly applies. Registered by A. Maxwell, 41, Bishopsgate Street, E.C.

The National Engineering Supply Company, Limited (3,808).—Registered at Edinburgh March 18th with capital £2,000 in £1 shares, to carry on the business of steam and electrical engineers, machinery and metal merchants, and agents. The subscribers (with one share each) are:—T. McStraith, 70, Wellington Street, Glasgow, accountant; M. Brown, 5, Hayfield Terrace, Glasgow, merchant; W. Thorn, 14, Scott Street, Bridgeton, Glasgow, clerk; J. Smith, 70, Wellington Street, Glasgow, engineer; A. Paterson, 109, Bath Street, Glasgow, writer; G. Chapman, 109, Bath Street, Glasgow, writer; J. McTaggart, 78, Kelvin Street, Glasgow, builder. Directors are to be afterwards appointed; qualification, 100 shares. Registered by Breeze, Paterson & Chapman, 109, Bath Street, Glasgow. Registered office, 312, Argyle Street, Glasgow.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Headland's Patent Electric Storage Battery Company, Limited (45,524).—This company's annual return was filed on January 18th, when 19,665 shares were taken up out of a capital of £20,000 in £1 shares. 14,993 are considered as paid, £1 per share has been called on seven, and 10s. per share on the remainder. £2,389 10s. has been received, which includes £50 paid in advance.

Harp Arc Lamp Syndicate, Limited (41,057).—As this company is not doing any business, the secretary has requested that its name be erased from the Register of Joint Stock Companies.

Buenos Ayres Electric Light Company, Limited (16,057).—This company's annual return was filed on January 1st. The capital is £100,000 in 9,986 shares of £10 each, and 70 founders' shares of £2 each. All the latter have been subscribed for, but no calls have been made.

CITY NOTES.

Hanley Corporation Accounts.

Notwithstanding the short period for which the loans in the case of Hanley have been granted, the electricity works are rapidly arriving at a profit-earning stage, after paying contributions to sinking fund and interest on loans. The following paragraphs from the engineer's report are worth quoting:—

"The total expenditure was £4,000 7s. 8d., and the total receipts were £6,520 1s. 7d., according to the Board of Trade returns, leaving £2,519 13s. 11d. as the gross profits of the undertaking to be carried to the net revenue account. This amount represents a profit of 4·88 per cent. on the capital expended. The receipts do not show such an increased consumption as was hoped for by the reduction in price from 6d. to 5d.; in fact, the customers who formerly paid 6d., taken collectively, and of course including corporation buildings, have consumed less current in 1897 than in 1896. This seems conclusively to point out that a much greater inducement was necessary to bring in long-hour consumers, and this has now been given; but owing to hesitation on the part of intending customers, the good results may not come immediately. The lowering of the price, particularly to private houses and to shops having long hours should, however, during the ensuing few years, prove to be a wise and sound course, unless Hanley is to be different from all other places.

"It will be noted that notwithstanding the reduction in price, the very great addition to the sum required to be paid to the sinking fund and the large sums expended in maintenance, rates and taxes, that the deficiency is so small an amount as £188 11s. 1d. on a gross income of £6,520. A very few additional customers would have converted that amount into a net profit, in fact, the new connections made already more than warrant the belief that such a sum will be cleared off in the first half-year. The effect of the new optional charges is, of course, a distinct matter. If the price had remained at 6d. and the same quantity sold, the income would have been £1,000 more. On the other hand, the lowering of the price has undoubtedly brought new customers in, and it is only reasonable to estimate that the loss caused by the new charges during the first half of this year will be balanced by the gain in the second half."

The following table shows the increase in the various items:—

Increase.

Capital expenditure.	Output in units.	Working expenses.	Revenue from sale of current.
£7,491	3,881	£1,400	£1,930

The following table gives the cost per unit:—

	1897.	1896.
Total capital expended	£51,634	£44,143
Number of units sold	351,762	247,881
Number of lamps connected	—	—
Revenue from sale of current	£6,292	£4,362
Net revenue	£2,520	£1,791
Average price obtained per unit	4·2d.	4·5d.

Cost of production.	£		Per unit.	1896.
Coal	1,003		·68d.	·73d.
Oil, waste, water, and engine room stores	226		·15d.	·19d.
Salaries and wages at generating station	887*		·60d.	·57d.
Repairs and maintenance of buildings, engines, boilers, dynamos, &c.	992*	(Works' cost 2·07d.)	·67d.	·50d.
Rent, rates and taxes	357		·24d.	·15d.
Management expenses, directors' remuneration, salaries of managing engineer, secretary, clerks, &c., stationery and printing, general establishment charges, auditors, law charges, and insurance	535		·36d.	·38d.
Depreciation of buildings and plant account	—		—	—
Renewal fund account	—		—	—
Total	£4,000		2·70d.	2·52d.

Revenue.	£	s.	d.	Average price obtained per unit.
By sale of current	6,292	0	0	4·2d.
Meter rents, &c.	150	0	0	—
Supply of steam	—			—
Transfer fees	—			—
Other items	78	0	0	—
Total	£6,520	0	0	4·2d.

* Attending and repairs of arc lamps (£295) added to these two items.

Total cost per unit (exclusive of depreciation and renewal accounts), 2·67d.; works' cost, 2·07d.

The Hove Electric Lighting Company.

This company continues to make substantial progress, and though it has, during the past year, made a considerable reduction in the price charged for electricity, there is every reason to anticipate an increased *clientèle* from that cause alone. There is a marked decrease in the cost of production, the most striking being in the repairs and maintenance account, which stands at £209, against £340 last year. Considerable extensions to the company's systems have taken place, and probably the next accounts will demonstrate the benefits arising from enlarging the scope of the company's operations.

The increase in the various directions are indicated below:—

Increase.

Capital expenditure.	Output in units.	Working expenses.	Revenue from sale of current.
£4,874	67,681	£262	£677

The following table gives the cost per unit:—

	1897.	1896.
Total capital expended	£66,896	£62,022
Number of units sold	268,243	200,562
Number of lamps connected	27,777	21,794
Revenue from sale of current	£6,839	£6,162
Net revenue	£3,602	£3,114
Average price obtained per unit ...	6·11d.	7·39d.

Cost of Production.	£		Per unit.	1896.
Coal	805		·72d.	·79d.
Oil, waste, water, and engine room stores	119		·11d.	·16d.
Salaries and wages at generating station	785		·70d.	·88d.
Repairs and maintenance of buildings, engines, boilers, dynamos, &c.	209	(Works' cost 1·72d.)	·19d.	·41d.
Rent, rates and taxes	184		·16d.	·27d.
Management expenses, directors' remuneration, salaries of managing engineer, secretary, clerks, &c., stationery and printing, general establishment charges, auditors, law charges and insurance	1,172		1·04d.	1·28d.
Depreciation of buildings and plant account	—		—	—
Renewal fund account	—		—	—
Total	£3,274		2·92d.	3·79d.

Revenue.	£	s.	d.	Average price obtained per unit.
By sale of current	6,839	0	0	6·11d.
Meter rents, &c.	—			—
Supply of steam	426	0	0	—
Transfer fees	4	0	0	—
Total	£7,269	0	0	6·11d.

Total cost per unit (exclusive of depreciation and renewal accounts), 2·92d.; works' cost, 1·72d.

The Electric Installation Company, Limited.

This company has been formed for the purpose of making installations of electric plant for lighting or other purposes in public institutions, hotels, mills, factories, collieries, warehouses, shops, &c., on the hire-purchase system or on a rental. It is not proposed that the company should manufacture the different appliances required in such installations, but that its revenue should be derived from payments to be made for the hire and rental of electric plant. Generally, arrangements with customers would be such that all claims against them would be satisfied after the rental had been paid for 10 years. It is obvious that such a scheme calls for heavy expenditure, and it is not surprising, therefore, to find that the capital of the company which is courageous enough to embark upon such an enterprise is £100,000 in £1 shares. The immediate call is for 2s. 6d. on application and 2s. 6d. on allotment. In a sense, the company may be considered a Manchester one. The directors are mainly Manchester merchants, the offices of the company are in Manchester, and the consulting engineer is Mr. F. F. Bennett, of Manchester. No doubt Lancashire and the north country generally presents a very favourable field for the operations of the company, and we see little reason why it should not meet with some success. It is exceptional, not to say remarkable, that in this company no promotion money will be paid; there are few electrical companies that can say the same.

Brockie-Pell Arc Lamp Company.

The report of this company, covering a period of 17 months, has just been issued, but it is impossible in this issue to do more than make a few extracts from it. Profit and loss account show on the debtor side, £7,737, the principal items of which are, directors' fees, £1,676; and salaries, £3,257. The credit side shows manufacturing gross profit, £2,085, and royalties nearly £1,000, there being practically a loss of £4,590 on the 17 months' working. According to the report, this is mainly due to the time taken in equipping the works with the various machines for the making of the lamps. The first 100 lamps, made entirely at the company's factory in Tabernacle Street, were not completed till the end of July last, so that the business has only been in full swing for a period of from five to six months. Orders for lamps received from month to month, show a steady increase. A contract has been signed for the disposal of the French and Belgian patents for £3,000, of which £500 has been received on account.

Chelsea Electricity Supply Company, Limited.

Mr. J. Irving Courtenay presided at the general meeting of this company held last Thursday, and said it was a pleasure to him to be able again to report a continual improvement in the results obtained. The £60,000 ordinary share capital subscribed in 1896 did not rank with the ordinary capital previously subscribed until 1897, and, notwithstanding this additional capital, the increase in the business had enabled them to show a profit which would allow of 6 per cent. being paid on the ordinary shares, as compared with 5 per cent. on the smaller capital of previous years, carrying forward a balance of £1,652 4s. 1d. to meet contingencies. That the public was now fully alive to the value of the electric light was amply demonstrated by the substantial addition to their circuits of over 16,000 lamps during the year, and the large increase in the use of the light generally throughout the metropolis and in the provinces. That fact was of itself an explanation of the necessity for the expansion in capital expenditure, and so long as this expenditure brought an increasing return, none would have cause to complain. They had added a valuable security to the property in the form of freehold land, and substantial buildings on this land, to the extent of over £20,000, and had increased the plant, machinery, mains and meters by nearly £35,000. The progress during the year had been continuous and steady, and it really seemed as if an average of 16,000 or 18,000 lamps annually would continue to be added. They must, however, make provision for somewhat larger additions, because it frequently happened that a new estate would be completed, and shops and offices all opened at once; constant care was exercised by the staff in watching the progress of the various estates. The new sub-station in Pavilion Road was of sufficient capacity to cope with the maximum demand ever likely to arise in its neighbourhood. They had laid, during the year, about 9¼ miles of casing, which was capable of accommodating about 36 miles of conductor, and had actually drawn in during the year some 16¼ miles of conductor into the ways just mentioned. There were added during the year 16,178 lamps, or their equivalent in the 12 months, so that the total number of lamps on December 31st was 96,758, since which they had passed the hundred thousand. The chairman then referred to the compulsory purchase of property adjoining, and in the neighbourhood of, their works in Chelsea, for which a Bill had been promoted in Parliament. The cost of production had been slightly reduced, and, from the character of their district, the improvements introduced in their machinery, and the indications in the present accounts, they might fairly expect progressive improvement in the return on capital. In regard to vibration troubles, their works were now equipped with the most recent type of plant, and every precaution that the best practical experience could suggest had been taken, and as they had, in addition, made a careful inspection of the property in the neighbourhood, they had no fear of the ultimate issue of any complaints that may be made against the company.

The report and accounts were then adopted.

South London Electric Supply Corporation.

The ordinary general meeting of the South London Electric Supply Corporation, Limited, was held on Monday last at Winchester House, E.C., Mr. George Ellis, J.P., presiding.

The Chairman said: Steady progress was being made in all directions. Most new undertakings suffered from delays; theirs, so far, had not been very serious, and had been amply compensated for by the acquisition of the site which they had succeeded in obtaining after lengthy negotiations. It was practically in the centre of the area of supply; it required no clearing and hardly any levelling, and the three acres of freehold land cost under £10,000; a better site for the operations there could not be. Referring to the accounts, a certain proportion of the administration expenses had been allocated to the cost of land, buildings, machinery, plant and mains. It had been stated that no dividend could be paid till the cost of the order and expenses, amounting to £47,000, had been paid off. This was not true; the expenditure could be placed to a suspense account. The Board of Trade would allow a dividend to be paid so long as a suitable amount was set aside for the extinction of the item. No doubt some of them had been told that £47,000 was a large sum for this order and the expenses. On the face of it, it does seem large, but it is not so in fact. The Board of Trade insisted upon the capital being underwritten to the extent of £200,000 before they would let this company have the order, and that in itself, with the brokerage, absorbed £24,000 of the amount. He should like to compare the expenditure with that of two other large companies in London—namely, the Westminster and the St. James's Companies—and to say that their order had not cost them one-half of what theirs had cost them, because in one case they had had to redeem their founders' shares at a cost of £120 000, and in the other case he believed at £150,000, whereas £47,000 was the absolute cost to them of this order. With regard to the issue of the balance of the share capital, the facts of the case are these: the shares subscribed for gave them a little over £200,000 to fulfil contracts and carry out works involving an expenditure of about £300,000. In July last they could not get more capital, as the shares were considerably below par, and it was illegal to issue shares at a discount. Any offer to the shareholders which it had been suggested should have been made, would still further have depreciated the shares and have thus added to the difficulties. The board had many serious consultations, and at last most reluctantly instructed their engineer to cut down the contracts; but then arose an unforeseen difficulty. They were under an obligation to the Lambeth Vestry to build a dust destructor capable of burning a certain number of tons of refuse per annum, so that this, the largest contract, could not be reduced. They, however, arranged to cut down the engines, cables, and other machinery by one-third, but they did this only as a last resource, as they knew full well that this meant doing away with any possibility of early dividends; but there was, at that time, no other course open to them. However, on July 29th, Mr. Cook, a gentleman whom the board knew to be connected with a strong group of financiers, called on the board and offered to take the 1,530 shares necessary to obtain a Stock Exchange quotation, at par—although shares could be purchased in the open market at a considerable discount—conditionally upon giving him an option at par for the balance up to December 1st. Mr. Cook told them in the most straightforward manner that he was representing some financial gentlemen of considerable means, and the inference they drew from this statement was that it was almost certain the option would be exercised, and that the necessary funds for carrying out the scheme in full were sure to be provided. Mr. Cook, however, found some difficulty at the outset in making his arrangements, as so many people had left London for the holidays, and at the next board meeting he asked for a month's grace. This was agreed to, and at the end of that time the cheque was forthcoming, and application for a Stock Exchange quotation was duly made and granted. Subsequently Mr. Cook transferred his option to Mr. Atherton, the gentleman who had some months previously promoted the company, and he at the expiration of the option at the end of November, came to the board and offered to take up and pay for the whole of the shares covered by it if the board so desired. He, however, made another proposal, to the effect that he should then only take up and pay for 12,500 shares out of the 21,659, leaving the balance—namely, 9,159—over until March 1st, and paying to the company interest at the rate of 4 per cent. on the £18,318. The board thereupon considered which of these two offers would be most beneficial to the company, and came to the conclusion that Mr. Atherton's second proposal was the better. They had read Mr. Wheelock's circulars, and he (the chairman) had told them the facts. As directors, they had only to consider the true interests of the company. With no quotation, with shares at a discount, and insufficient capital at their command to carry out their programme, the directors were satisfied that in placing the balance of capital as they did, they acted as men of business in the interests of the shareholders. None of the directors had any interest in the allotment made to Mr. Atherton, either directly or indirectly. In order to show that they had not allowed the work to lag, he might mention that the local authorities had represented that the progress in laying the mains was somewhat too rapid to enable them to keep pace with the company in the work of reinstating the streets, a compliment which was most satisfactory. The chairman then moved the adoption of the report.

Mr. Brooke-Hitchin seconded the motion.

Mr. A. Brooke moved the following amendment: "That the report be received but not adopted, and that a committee of five shareholders be appointed, with power to add to their number, to inquire into the formation and past management of the company, and the relations between the board and the promoter, and with power to call for books and documents, and to obtain such legal and professional assistance as may be necessary, such committee to report to a meeting to be called for Monday, April 18th, 1898."

After some discussion the amendment was negatived, only four votes being recorded in its favour, and the report and accounts were adopted.

The Direct Spanish Telegraph Company, Limited.

The report and accounts of the directors for the year ended December 31st, 1897, to be presented at the yearly general meeting of shareholders, to be held on Tuesday, March 29th, 1898, states that the accounts for the year ended December 31st, 1897, show, after providing for interest on, and redemption of, debentures, a balance to the credit of revenue of £12,975 6s. 4d. After adding the usual sum of £5,000 to the reserve fund, the balance will amount to £7,975 6s. 4d., and the directors recommend the declaration of dividends for the year 1897, of 10 per cent. on the preference shares, and 4 per cent., free of income-tax, on the ordinary shares, absorbing £5,486 4s. Half of this amount was distributed on October 1st, 1897, as an interim dividend in respect of the half-year ended June 30th, 1897.

The traffic receipts show a decrease of £2,927 3s. 11d., as compared

with the year 1896, when, as stated in last year's report, the increase was due to exceptional circumstances. The reductions of rates, and the mode of counting the words in telegrams, adopted at the Buda-Pesth Conference, came into force on July 1st, 1897, and have, as was expected, adversely affected the company's receipts.

The working expenses are £223 8s. 11d. in excess of those for the year 1896. The company's cables and land lines in connection with them have continued in good working order throughout the year. In the report of the directors of September 11th, 1894, it was stated that the construction of a new breakwater at Bilbao placed the company under the necessity of removing the shore end of the Falmouth-Bilbao cable to a point outside the new breakwater, and that the cost of this removal was chargeable to the harbour authorities at Bilbao.

The directors regret that the liability of the harbour authorities was not admitted by the Spanish Courts. The cost of the removal of the shore end, amounting to £3,514 5s. 2d., has, therefore, been debited to the reserve fund, and it is proposed that the balance of the revenue account, amounting to £2,489 2s. 4d., be transferred to the reserve fund towards the payment of this amount, and that the £1,025 2s. 10d., required to make up the cost of the removal, be repaid to the reserve fund out of future revenue. The reserve fund now amounts to £44,769 11s. 2d. The directors report, with extreme regret, the death of Mr. Edmund Etlinger, who had been a director of the company since its formation in 1872. The directors have filled the vacancy so caused by the appointment of Mr. F. Alexander Johnston.

In commemoration of Her Majesty's Diamond Jubilee, the directors have granted a bonus to all employés in the company's service.

Mr. F. Alexander Johnston is the director retiring by rotation, and offers himself for re-election. The auditors, Messrs. Deloitte, Dever, Griffiths & Co., retire, and offer themselves for re-election.

Willans & Robinson, Limited.

The eighth half-yearly report of the directors, to be submitted at the ordinary general meeting of the company, to be held at the City Terminus Hotel, Cannon Street, London, at 3 p.m., on Wednesday, March 30th, 1898, states that the accounts for the half-year ended December 29th, 1897, are submitted herewith. After writing off as depreciation from plant, patents, &c., the sum of £5,277 8s. 4d. (against £4,162 11s. 2d. last half-year), and paying interest upon debenture stock, the balance to the credit of profit and loss account for the half-year (including £1,559 13s. 7d. brought forward) is £16,053 0s. 10d. Out of this the directors propose that dividends be paid at the full rate of 6 per cent. per annum upon the preference shares, and at 8 per cent. per annum upon the ordinary shares, together amounting to £8,707 17s. 7d. The amount payable to the original directors, in accordance with the articles of association, is £1,832 5s., leaving a balance of £5,512 18s. 3d. From this the directors propose to carry £2,000 to the debenture redemption fund, and £1,500 to the reserve fund (against £1,000 last half-year), leaving a balance of £2,012 18s. 3d. to be carried forward. The directors feel that the satisfactory results of the half-year's trading, achieved under circumstances not altogether favourable, coupled with excellent prospects for the future, justify them in recommending a moderate increase of dividend.

In accordance with the announcements made in the last report, applications have been invited from the shareholders for the balance of the unissued shares, viz., 3,000 preference and 3,000 ordinary shares.

As required by the articles of association, two of the directors, viz., Mr. Robinson and Capt. Sankey, retire, but are eligible, and offer themselves for re-election.

The auditors, Messrs. Cooper Bros. & Co., also retire, but are eligible for re-election.

Hastings Electric Light Company.

The annual meeting was held last week at the Queen's Hotel. Mr. F. A. Langham presided.

The Chairman, in moving the adoption of the report and balance-sheet, said they had to work for three years under a losing contract. It was difficult to say how much they lost, but certainly several hundreds a year, through being originally misinformed as to the cost of producing the light. They had had to feel their way, and unfortunately they had to pay for it. Now that was at an end it was evident they had a good and prosperous concern, and he thought nothing showed it more than the figures which they had alluded to in their report, comparing the receipts for the light supplied as against the cost of production. For his own part, and on the part of the directors, he must say they were deeply indebted to Mr. Andrews and to those who were working under him for the pains they had taken to obtain the result of economy which was shown in that report. He thought it did great credit to their staff that with increased receipts and increased working, although they had been able to earn about £1,600 more, it should have been done at an additional cost of under £200. Their receipts had been steadily increasing for the past three years. In 1895 they were £6,090; in 1896 they had increased to £7,086, and in 1897 they rose to £8,734; therefore, it was a regularly increasing business. They were taking more money each year, and they had fair grounds for supposing, with contracts in hand, and the orders given to them, that that state of things would extend to the present year also. Their working expenses in 1896 to earn £7,086, were £5,164, whereas in earning £8,734 in 1897, their expenses were only £5,361, so that in earning £1,600 or £1,700 more, they expended something under £200 more in the working. It was very agreeable to them to find that the popularity of the light was increasing, and that they got new customers, because, of course, as soon as they ceased to supply the town—which they were still doing, although on more remunerative terms—they would have spare light for private customers. As they knew, since their last annual meeting, they had had a special general meeting, at which the shareholders unanimously adopted the suggestions of the board, that the contract with the Corporation should be entered into. That contract was accordingly entered into; but at present nothing further had been done, because the Corporation were seeking to obtain their provisional order, without which they could not take the works over. They, at present, were still lighting the front line under arrangement with the Corporation from month to month, until the Town Council were able to supply light for themselves. But they did not anticipate, even when they lost this lighting, that they would sustain any loss, because they had considerable demands for private lighting, which they could carry out, but which they had been afraid to add to the burden on the machinery already taxed with the public lighting.

Mr. A. Bray seconded the motion, which was adopted.

The Metropolitan Electric Supply Company, Limited.

The report of directors to be presented at the ordinary general meeting next Tuesday at Winchester House, states that the directors submit a statement of the company's accounts for the year ending December 31st, 1897, prepared in the form prescribed by the Board of Trade under the provisions of the Electric Lighting Acts, 1882 and 1888.

The capital expenditure, which at the end of 1896 amounted to £757,035 13s. 11d., has now reached a total of £850,831 10s. 9d., the increase during the year having been £93,795 16s. 10d. The principal items are mains and apparatus, and the purchase of a site for future extensions. The balance of capital in hand at the end of the year was £29,597 18s. 10d. The gross revenue for the year amounted to £134,267 14s. 6d. against £116,459 4s. in 1895, being an increase of £21,808 10s. 6d. The cost of generation, which in 1896 was £52,619 4s. 9d. amounted in 1897 to £58,604 5s. 4d., or an increase of £5,985 0s. 7d.

The balance to the credit of the revenue account, before providing for depreciation, is £58,721 10s. The directors have set aside £15,000 as an addition to the depreciation account carrying to the credit of the net revenue account, the sum of £43,721 10s. which, with the balance brought forward from last account and other receipts, makes a total of £46,947 3s. 6d. After deducting debenture and share interest and other charges, there appears a balance of £22 989 6s. 6d. An interim dividend of 5s. per share on the ordinary share capital was paid on October 15th, 1897, amounting to £12,475, and the directors recommend that a further dividend of 7s. per share on such shares be now paid, making a total distribution of 12s. per share for the year, or 6 per cent. on the capital. The dividend upon the new shares being for six months only, will be 6s. per share, or one-half the total amount of dividend upon the original shares. This will absorb a further sum of £21,215, and leave a balance of £1,774 6s. 6d. to be carried forward to the next account.

The number of 8-candle-power lamps supplied by the company increased during the year 1897 from 308,000 to 360,000. The present number of lamps connected is 374,000, and the applications show no signs of decrease. A report from the company's engineering director is appended, showing that the satisfactory condition of the stations, machinery, and plant has been maintained.

In accordance with the articles of association, the following directors, viz:—Admiral of the Fleet Lord John Hay, G.C.B., W. Harrison Cripps, Esq., and John Birkbeck Lubbock, Esq., retire from the board, and are eligible for re-election. The auditors, Messrs. Deloitte, Dever, Griffiths & Co., also retire, and are eligible for re-election.

Sheffield Electric Light Company.

The annual meeting of the company was held on Monday last at the Cutler's Hall, Sheffield.

The Chairman of the Board (the Lord Mayor, Alderman Franklin) presided at the ordinary meeting, and in moving the adoption of the report, congratulated the shareholders upon the sound financial position of the company, and in several ways pointed to unmistakeable proofs of progress. In 1893 the revenue from the sale of current was £3,555, and it increased year by year until in 1897 it reached £14,318. The profits had increased in the same way, and for the past year amounted to £11,392, out of which it was proposed to pay a dividend of 12½ per cent., and carry forward £902. The output was 747,067 units, against 483,427 units in 1896 and 288,406 in 1895. The greatest percentage of increased output was in 1896, when the increase was 67 per cent., against 54 per cent. last year, but the reason of that was that owing to the impossibility of getting additional machinery, chiefly in consequence of the engineering dispute, the company declined to receive new customers for several months. He alluded to, and laid stress upon, the decreased cost of production, stating that in 1893 the cost of production was 5·44d. per unit, in 1894 3·8d., in 1895 3·6d., in 1896 2·23d., and in 1897 1·56d. Within a period of 15 months the directors had brought down the cost of production from 2½d. per unit to about 1½d. The directors were convinced they had a valuable property, and they were well satisfied with the progress which had been made.

Alderman Gamble seconded, and the report was adopted, as was also one declaring a dividend of 12½ per cent.

A special meeting followed, to approve the sale of the undertaking to the Corporation of Sheffield.

The Chairman moved the formal resolution, agreeing to sell to the Corporation, and the resolution was unanimously carried.

Manchester Electrical Works, Limited.

The following report and balance-sheet have been sent out to the shareholders of the Manchester Electrical Works, Limited (successors to Woodhouse & Rawson):—

"147, Leadenhall Street, E.C., *March 9th*, 1898.

"Sir or Madam,—Your directors have not considered it necessary to call a general meeting of shareholders during the past year, because they prefer to have some definite proposals to place before you regarding the disposal of the works, which they have been endeavouring to bring about on behalf of the shareholders. Negotiations for the sale are still pending, and as soon as a firm offer can be secured at a sufficient price, a meeting of the shareholders will at once be called to confirm the sale. In the meantime the money that you have subscribed is secured by a charge on the plant and stock, and carries with it 5 per cent. interest until such time as it is repaid. Your directors beg to forward balance-sheet, showing the financial position on December 31st, 1897. You will notice that the total expenditure for salaries and office expenses since the incorporation of the company amounts to £153 2s. 6d. There has been, and will be, no further addition to this item, and your directors will continue, as in the past, to waive their fees.

"Yours faithfully,

"Willoughby Wallace, *Chairman*."

The British Insulated Wire Company, Limited.

The first ordinary general meeting of this company was held last week at the Exchange Station Hotel, Liverpool, Mr. W. Marriner Brigg, chairman of the board of directors presided. There were also present Mr. E. K. Muspratt, Mr. S. Z. de Ferranti, Mr. J. B. Atherton, and Mr. J. E. Pearson, directors; Mr. F. J. Leslie, solicitor; Mr. Edward Tracey, secretary, and a considerable number of shareholders.

The report, which was for the first eight months of the company's working, ending December 31st last, stated that the net profits for that period were £33,281, which the directors regarded as very satisfactory, being in excess of the estimate in the prospectus. They recommended a dividend at the rate of 15 per cent. on the ordinary shares.

The Chairman, in moving the adoption of the report and accounts, expressed the pleasure of the directors at meeting the shareholders under such happy circumstances. They had already found it necessary to enlarge their working premises, and further buildings were in progress, in order to enable them to keep pace with the orders in hand. Fortunately their area of land at Prescot was large enough for the extensions required, and already a competent authority had informed him that they had the most complete and best laid out works in the country. When the new company took over the business they had £200,000 worth of orders on hand. The figure now stood at £300,000, and personally, he felt confident that ere long they would require a further issue of capital in order to keep pace with the demands upon them. He was satisfied that they could employ a very much larger capital profitably. He, therefore, felt entitled to congratulate the shareholders, both as to what they had already done and on the excellent prospects before them.

Mr. Berry seconded the motion, which, after a brief discussion, was unanimously adopted, and a dividend was declared as recommended.

On the motion of Mr. Muspratt, the retiring directors, Messrs. W. M. Brigg and Ferranti, were unanimously re-elected, and Messrs. Chalmers, Wade & Co. were re-appointed auditors.

A hearty vote of thanks to the chairman and directors concluded the proceedings.

Norwich Electricity Company.

The ordinary general meeting of the shareholders was held last week. The chairman, Mr. F. W. Harmer, presided.

The Chairman said he trusted that the report which they held in their hands would be looked upon as satisfactory. The most interesting item of the report was the balance, either to the debit or credit of the account, and the amount which was allotted for the purpose of dividend. They had never had a debit balance yet, and he hoped that they never would have. At the end of the first year's working they had declared a modest dividend of 3 per cent., and they had been able to make it a little better each year. 1897, he was glad to say, was the best they had had. He hoped the shareholders would think that the 5½ per cent. now declared was very fair for a young company like their own, and it was especially gratifying because, as they knew, 12 months ago the price of current had been reduced 12½ per cent. Owing, however, to economy in working, and to the fact that they had acquired a large number of new customers the result of the year's working was even more than that of 1896. The directors were increasingly satisfied that they had adopted the right system of producing electricity, and that was a very important matter. As to economy of working they might compare with the best companies in England. The price at which they were making electricity was considerably below the average of the whole country, even including those of the Midland counties where coal was much cheaper than it was in Norwich. The capital account had been kept down to the lowest possible figure, and, compared with the revenue they obtained for it, was below the average. The most interesting feature which he had to report was that they did not seem to be getting to the end of their prosperity. They were acquiring new customers at this moment as fast as they were last year at this time, or, indeed, at any period in their history. They had lately adopted a system of free wiring, which would probably bring them a considerable amount of new business, which they could not have obtained in any other way. The directors had not only put aside this year a certain amount for depreciation, but also another sum as reserve. Machinery was constantly wearing out, and it was not so valuable at the end of a year's working as at the beginning. The company had been applied to to supply electricity in Thorpe, and they were now applying to Parliament for an Act to enable them to do so.

The report, after some discussion, was adopted.

Brush Electrical Engineering Company.—The interim report of the directors of the Brush Electrical Engineering Company for the six months ending December 31st last states that the works at Loughborough have been fully employed, and the volume of orders received during the half-year has been above the average of the past few years. In consequence of the increasing demand for the company's manufactures in connection with electric traction, the directors are largely extending the capacity of the works for the output of motors and cars. Other extensions of the works at Loughborough, rendered necessary by the development of the company's general business, are in progress. A final settlement of the matters in dispute with the City of London Electric Lighting Company has been effected. An interim dividend for the half-year at the rate of 6 per cent. per annum has been declared on the company's preference shares.

Stock Exchange Notices.—Application has been made to the Committee to appoint a special settling day in, and to grant a quotation to, Westminster Electric Supply Corporation, Limited—£200,000 3½ per cent. first mortgage debentures.

The Committee has appointed Tuesday, March 29th, a special settling day in W. T. Henley's Telegraph Works Company, Limited—Further issue of 2,500 ordinary shares of £10 each, fully paid, Nos. 10,001 to 12,500; and ordered the undermentioned to be quoted in the Official List:—St. James's and Pall Mall Electric Light Company, Limited—Further issue of 12,000 ordinary shares, Nos. 40,081 to 52,080; W. T. Henley's Telegraph Works Company, Limited—Further issue of 2,500 ordinary shares, Nos. 10,001 to 12,500.

Costa Rica Electric Light and Traction Company, Limited.—The share capital of this company, which has been formed to supply electric light and operate electric tramways in San José and Cartago and to take over existing works, is £130,000, in £1 shares, which are taken by the vendor in part payment of the purchase money, £130,000 5 per cent. first debentures being offered for subscription at the price of 90. These are repayable at par on January 1st, 1948, and may meanwhile be redeemed at six months' notice at 105 per cent.

Central London Railway.—A special meeting of this company was held last Saturday for the purpose of authorising an increase in the number of directors, and for the election of Sir Henry Oakley as a director. The motion was adopted, and subsequently Sir Henry Oakley was elected chairman of the company.

Metropolitan Electric Supply Company.—The ordinary general meeting will be held on 29th inst., at noon, at Winchester House. The transfer register of the ordinary and new ordinary shares will be closed from 19th to 29th inst., both days inclusive.

Bournemouth and Poole Electricity Supply Company.—The first ordinary general (statutory) meeting will be held at Winchester House, Old Broad Street, E.C., on the 28th inst., at 2 p.m.

Eastern Telegraph Company, Limited.—The usual interim dividend of 2s. 6d. per share on the ordinary shares, free of tax, in respect of the quarter ended December 31st, is announced.

Brockie-Pell Arc Lamp, Limited.—This company notifies that the transfer books of the company will be closed from March 22nd to April 4th, 1898, both days inclusive.

TRAFFIC RECEIPTS.

The Bristol Tramways and Carriage Company, Limited.—The receipts for the week ending March 18th, 1898, were £2,503 3s. 4d.; corresponding period, 1897, £2,053 7s. 5d.; increase, £449 15s. 11d.

The Cape Electric Tramways.—The receipts for February were: Cape Town, £8,600; Port Elizabeth, £2,275.

The City and South London Railway Company.—The receipts for the week ending March 20th, 1898, were £1,030; week ending March 21st, 1897, £1,012; increase, £18; total receipts for half-year, 1898, £12,826; corresponding period, 1897, £12,818; increase, £8. Miles open, 3½.

The Dover Corporation Electric Tramways.—The receipts for the week ending March 19th, 1898, £117 17s. 5d.; total receipts to March 19th, 1898, £1,166 8s. 11d.

The Dublin Southern District (Electric) Tramways Company.—The receipts for week ending Friday, March 18th, 1898, were £403 4s. 6d.; corresponding week last year, £363 15s. 4d.; increase, £39 9s. 2d.; passengers carried, 68,513; corresponding week last year, 59,721; aggregate to date, £4,378 17s. 11d.; aggregate to date last year, £4,669 13s. 10d.; decrease to date, £290 15s. 11d.; mileage open, 8 miles.

The Liverpool Overhead Railway Company.—The receipts for the week ending March 20th, 1898, amounted to £1,316; corresponding week last year, £1,360; decrease, £44.

The Western and Brazilian Telegraph Company, Limited.—The receipts for the week ending March 18th, 1898, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brasilian Telegraph Company, Limited, were £2,933.

SHARE LIST OF ELECTRICAL COMPANIES.

TELEGRAPH AND TELEPHONE COMPANIES.

Present issue.	NAME.	Stock or Share. †	Dividends for the last three years. 1895.	1896.	1897.	Closing Quotation, March 16th.	Closing Quotation, March 23rd.	Business done during week ended March 23rd, 1898. Highest.	Lowest.
137,400£	African Direct Teleg., Ltd., 4 % Deb.	100	4 %	...	...	100 -104	100 —104	...	...
25,000	Amazon Telegraph, Limited, shares...	10	...	...	...	7 — 8	7 — 8	...	...
125,000	Do. do. 5% Debs. Red.	100	...	...	...	93 — 96	93 — 96	...	...
923,960£	Anglo-American Teleg., Ltd.	Stock	£2 9s.	£2 13s.	3 %	59 — 61	59 — 62	59½	...
3,038,020£	Do. do. 6 % Pref.	Stock	£4 18s.	£5 6s.	6 %	108½ 109½	109½ -110½	110½	109
3,038,020£	Do. do. Defd.	Stock	...	...	...	11½ — 12	11⅝ — 12¼	12 5/16	11 15/16
130,000	Brazilian Submarine Teleg., Ltd.	10	7 %	...	...	16¾ — 17¼	16¾ — 17¼	16⅞	...
75,000£	Do. do. 5 %, Debs., 2nd series, 1905	100	5 %	...	...	112 —116	112 —116	112½	...
44,000	Chili Telep., Ltd., Nos. 1 to 44,000	5	4 %	4 %	...	3 — 3½	3 — 3½	...	...
10,000,000$	Commercial Cable Co.	$100	7 %	7 %	...	187 —192	187 —192	...	...
918,297£	Do. Do. Sterling 500 year 4% Deb. Stock Red.	Stock	...	...	...	106 —108	106 —108	106⅝	105⅛
224,850	Consolidated Telep. Const. and Main., Ltd.	10/-	1½%	2 %	...	1/16 — 1/16	1/16 — 1/16	...	...
16,000	Cuba Teleg., Ltd.	10	8 %	8 %	...	6½ — 7⅛	6½ — 7⅛	7	6⅝
6,000	Do. 10 % Pref.	10	10 %	10 %	...	14½ — 15½	14½ — 15½	...	...
12,931	Direct Spanish Teleg., Ltd.	5	4 %	4 %	4 %	4 — 5	4 — 5	...	...
6,000	Do. do. 10 % Cum. Pref.	5	10 %	10 %	10 %	10 — 11	10 — 11	...	...
30,000£	Do. do. 4½ % Debs. Nos. 1 to 6,000 ...	50	4½%	4½%	4½%	103 —106%	103 —106%	...	...
60,710	Direct United States Cable, Ltd.	20	2¼%	2¼%	...	10⅝ — 11¼	10⅝ — 11¼	11¼	10⅞
120,000	Direct West India Cable 4½% Reg. Deb	100	...	...	...	98 —101	98 —101	...	...
400,000	Eastern Teleg., Ltd., Nos. 1 to 400,000	10	6½%	6½%	...	17⅜ — 18¼	17⅜ — 18¼	18 3/16	17⅝
70,000	Do. 6 % Cum. Pref.	10	6	6%	...	18½ — 19½	18½ — 19½	18⅝	...
89,900£	Do. 5 % Debs., repay. August, 1899	100	5 %	5%	...	100 — 103	100 —103	...	...
1,302,615£	Do. 4 % Mort. Deb. Stock Red.	Stock	4 %	4%	...	128 —131	128 - 131	...	...
250,000	Eastern Extension, Australasia and China Teleg., Ltd. ...	10	7 %	7%	...	18⅝ — 19¼	18⅝ — 19¼	18⅞	...
25,200£	{ Do. 5 % (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,325 }	100	5 %	5%	...	99 - 103	99 - 103	101	...
100,500£	Do. do. Bearer, 1,050—3,975 and 4,326—6,400	100	5 %	5%	...	100 — 103	100 —103	...	...
320,000£	Do. 4 % Deb. Stock	Stock	4 %	4%	...	128 —131	128 —131	128	...
35,100£	{ Eastern and South African Teleg., Ltd., 5 % Mort. Deb. 1900 redeem. ann. drgs., Reg. Nos. 1 to 2,343 }	100	5 %	5%	...	99 - 103	99 —103	...	...
46,500£	Do. do. do. to bearer, 2,344 to 5,500	100	5 %	5%	...	100 — 103	100 —103	...	...
300,000£	Do. 4 % Mort. Debs. Nos. 1 to 3,000, red. 1909	100	4 %	4%	...	102 - 105	102 —105	...	...
200,000£	Do. 4 % Reg. Mt. Debs. (Mauritius Sub.) 1 to 8,000	25	4 %	4%	...	108 — 111 %	107 —110%	...	...
180,227	Globe Telegraph and Trust, Ltd.	10	4½%	4½%	...	11⅜ — 12¼	11⅜ — 12¼	12⅛	11 13/16
180,042	Do. do. 6 % Pref.	10	6 %	6%	...	17½ — 18	17½ — 18	17⅞	17 9/16
150,000	Great Northern Teleg. Company of Copenhagen	10	10 %	10%	...	29 — 30	29½ — 30½	...	...
160,000£	Do. do. do. 5 % Debs.	100	5 %	5%	...	100 —103	100 —103	...	...
97,000	{ Halifax and Bermuda Cable Co., Ltd., 4½ % 1st Mort. Debs., within Nos. 1 to 1,200, Red. }	100	...	...	...	95 —100	95 —100	...	...
17,000	Indo-European Teleg., Ltd.	25	10 %	10%	...	52 — 55	52 — 55	...	...
100,000£	London Platino-Brazilian Teleg., Ltd. 6 % Debs.	100	6 %	6%	...	106 —109	106 —109	...	...
28,000	Montevideo Telephone 6% Pref., Nos. 1 to 28,000... ...	5	4 %	...	...	2 — 2½	2 — 2½	...	...
484,597	National Teleph., Ltd., 1 to 484,597	5	5½%	5½%	6 %	6½ — 6⅝	6½ — 6⅝	6⅝	6½
15,000	Do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	16 — 18	16 — 18	...	...
15,000	Do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	15 — 17	15 — 17	...	...
250,000	Do. 5 % Non-cum. 3rd Pref., 1 to 250,000	5	5 %	5 %	5 %	5⅜ — 6¼	5⅜ — 6¼	5 7/16	5⅜
1,329,471£	Do. 3½ % Deb. Stock Red.	Stock	3½%	3½%	3½%	102 —107	102 —107	104½	103½
171,504	Oriental Teleph. & Elec., Ltd., Nos. 1 to 171,504, fully paid	1	5 %	5 %	...	⅝ — ¾	⅝ — ¾	...	...
100,000£	Pacific and European Tel., Ltd., 4 % Guar. Debs, 1 to 1,000	100	4 %	4 %	...	105 —108	105 —108	...	...
11,839	Reuter's Ltd.	8	5 %	5 %	...	8 — 9	8 — 9	...	...
3,381	Submarine Cables Trust	Cert.	...	...	...	139 —144	140 —145	143½	...
58,000	United River Plate Teleph., Ltd.	5	4 %	...	...	4 — 4½	4 — 4½	...	...
146,733£	Do. do. 5 % Debs.	Stock	5 %	...	...	106 —109	105 —108	...	...
15,609	West African Teleg., Ltd., 7,501 to 23,109	10	4 %	nil	...	4 — 5	3½ - 4½	4¼	...
213,400£	Do. do. do. 5 % Debs.	100	5 %	5 %	...	101 - 104	101 - 104	...	...
64,269	Western and Brazilian Teleg., Ltd.	15	3 %	2 %	...	11½ — 12	11⅜ - 12¼	12 1/16	11 11/16
33,129	Do. do. do. 5 % Pref. Ord	7½	5 %	5 %	...	7½ — 8	7½ 8	7⅝	7⅜
33,129	Do. do. do. Def. Ord.	7½	... %	...	...	4 — 4½	4¼ — 4⅜	4⅜	4 5/16
389,521	Do. do. do. 4 % Deb. Stock Red. ...	Stock	...	...	...	106 —109	106 —109	108	107½
88,321	West India and Panama Teleg., Ltd.	10	⅛%	1 %	...	½ — ⅝	½ — ⅝	⅝	...
34,563	Do. do. do. 6 % Cum. 1st Pref.	10	6 %	6 %	...	8 — 8½	7½ - 8	8	7 15/16
4,669	Do. do. do. 6 % Cum. 2nd Pref	10	6 %	6 %	...	5 — 7	5 — 7	6⅝	...
80,000£	Do. do. 5 % Debs. No. 1 to 1,600 ...	100	5 %	5 %	...	105 —108	105 108	...	...
1,163,000$	Western Union of U. S. Teleg., 7 % 1st Mort. Bonds ...	$1000	7 %	7%	...	105 —110	105 -110	...	...
160,100£	Do. do. 6 % Ster. Bonds.	100	6 %	6%	...	100 —105	100 - 105	...	...

ELECTRICITY SUPPLY COMPANIES.

30,000	Charing Cross and Strand Electy. Supply	5	5 %	6 %	7 %	13½ - 14½	13½ 14½	...	...
20,000	Do. do. do. do. 4½ % Cum. Pref.	5	...	...	...	6½ — 6⅝	6½ - 6⅝	6 9/16	...
26,000	*Chelsea Electricity Supply, Ltd., Ord., Nos. 1 to 10,277 ...	5	5 %	5 %	...	11½ - 11⅝	10⅝ — 11½	11	...
60,000	Do. do. do. 4½ % Deb. Stock Red. ...	Stock	4½%	4½%	...	115 —117	115 —117	...	...
50,000	City of London Elec. Lightg. Co., Ltd., Ord. 40,001— 90,000	10	5 %	7 %	10 %	26 27 xd	26 - 27	26⅝	26½
10,000	{ Do. do. Prov. Certs. Nos. 90,001 to 100,000 £2 pd. }	10	...	...	...	13 — 14	12½— 13½	13½	12⅝
40,000	Do. do. 6 % Cum. Pref., 1 to 40,000	10	6 %	6 %	6 %	17½ — 18¼xd	17½ - 18½	17⅝	17⅜
4 00,000	Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid	...	5 %	5 %	5 %	129 134	129 —134	...	...
30,000	County of Lond. & Brush Prov. E. Ltg. Ltd., Ord. 1—30,000	10	nil	nil	nil	14⅜ - 15½	14⅜ — 15½	15½	14⅜
20,000	Do. do. do. 6% Pref., 40,001—60,000 ...	10	6 %	6 %	6 %	15⅜ - 16½	15⅜— 16½	15 13/16	...
17,400	Edmundsons Elec. Corp., Ltd., ord. shares 1—17,400 ...	3	...	...	...	3½— 3⅝	3½— 3⅝	3 7/16	...
10,000	House-to-House Elec. Light Supply, Ord., 101 to 10,100	5			...	11 — 12	11 — 12	11⅞	11½
10,000	Do. do. 7 % Cum. Pref. ...	5	...		...	11⅜— 12½	11⅜ — 12¼	...	...
49,900	*Metropolitan Electric Supply, Ltd., 101 to 50,000 ...	10	4 %	5 %	6 %	20⅜ — 21½	21 — 22	21⅜	21
12,500	Do. Ord., 50,001—62,500, iss. at £2 prem. ...	10	...	...	3 %	20½ — 21½	20½ - 21½	21	20½
220,000£	Do. 4½% first mortgage debenture stock	...	4½%	4½%	4½ %	117 —121	117 — 121	119	112½
6,452	Notting Hill Electric Lightg. Co., Ltd.	10	2 %	4 %	6 %	19½ — 20½xd	19½ — 20½	20⅛	20 1/16
31,980	*St. James's & Pall Mall Elec. Light Co., Ltd., Ord.	5	7½%	10½%	14½ %	18½ - 19½	18 — 19	19	18½
20,000	Do. do. 7 % Pref., 20,001 to 40,000	5	7 %	7 %	7 %	10 — 11	10 — 11	10¼	...
50,000	Do. do. 4 % Deb. stock Red. ...	Stock	...	...	4 %	107 —110	107 —110	...	...
43,341	South London Electricity Supply, Ord., £2 paid	5	...	...	...	2½— 2⅝	2⅜— 2⅝	2½	2⅜
79,900	Westminster Electric Supply Corp., Ord., 101 to 80,000 ...	5	7 %	9 %	12 %	17½ — 18⅝	17 18	18	17½

* Subject to Founder's Shares. † Quotations on Liverpool Stock Exchange.
‡ Unless otherwise stated all shares are fully paid. § Dividends paid in deferred share warrants, profits being used as capital.
Dividends marked ‖ are for a year consisting of the latter part of one year and the first part of the next.

SHARE LIST OF ELECTRICAL COMPANIES—*Continued*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL, COMPANIES.

Present Issue.	Name	Stock or Share. †	Dividends for the last three years. 1895.	1896.	1897.	Closing Quotation March 16th.	Closing Quotation March 23rd.	Business done during week ended Mar. 23rd, 1898. Highest	Lowest
30,000	British Electric Traction	10	..	...	...	16⅜— 17¼	16½— 17	16⅞	16 9/16
90,000	Brush Elect. Engng. Co., Ord., 1 to 90,000...	5	..	...	...	1⅝— 2⅛	1⅝ — 2	1⅞	1⅝
90,000	Do. do. Non-cum. 5 % Pref., 1 to 90,000	5	..	...	...	2¼— 2½xd	2⅛ — 2¼	2⅜	2⅛
125,000/	Do. do. 4½ % Perp. Deb. Stock.	Stock	..	...	...	110 —114	110 —114	...	...
50,000	Do. do. 4½% 2nd Deb. Stock Red. ...	Stock	...	...	...	102 —105	02 —105	...	...
19 894	Central London Railway, Ord. Shares	10	...	...	...	10½— 10⅝	10½— 11	10⅝	10⅝
129,179	Do. do. do. £6 paid	10	...	...	...	6½— 6⅝	6⅝— 6⅝	6½	...
59,254	Do. do. Pref. half-shares £1 pd. ...	...	...	...	...	1½— 2	1½— 2	...	...
67,680	Do. do. Def. do. £5 pd. ...	...	...	...	...	4⅝— 4⅞	4⅝— 4⅞	4⅝	...
630,000/	City and South London Railway	Stock	4¼%	1 1/16 %	1⅛ %	66 — 68	66 — 68	68	67½
28,180	Crompton & Co., Ltd., 7 % Cum. Pref. Shares, 1 to 28,180	7	nil	...	...	2¼— 2⅝	2 — 1½	2	...
99,261	Edison & Swan United Elec. Lgt., Ltd., "A" shrs, £3 pd. 1 to 99,261	3	5 %	5½%	...	2½— 3	2½ 3	2⅝	2½
17,139	Do. do. do. "A" Shares 01—017,139	5	5 %	5½%	...	4 — 5	4 — 5	...	...
194,023	Do. do. do. 4% Deb. stock Red. ...	100		...	...	103 —105	103 —105	106½	...
110,000	Electric Construction, Ltd., 1 to 110,000	2	5 %	6 %	...	2⅝— 2⅞	2⅝ - 2⅞	2⅞	...
16,343	Do. do. 7 % Cum. Pref., 1 to 16,343 .	2	7 %	7 %	...	3⅛— 3⅜	3⅛ - 3⅜	...	...
111,100	Do. do. 4% Perpetual 1st Mort. Deb. Stock	Stock	...	...	...	106 —108	106 —108	...	...
91,196	Elmore's Patent Cop. Deposg., Ltd., 1 to 70,000	2		.	...	1/16 - 3/16	1/16 - 3/16	...	...
67,275	Elmore's Wire Mfg., Ltd., 1 to 69,385, issued at 1 pm. ..	2		...	...	3/16 - 5/16	3/16 - 5/16	...	...
9,600/	Greenwood & Batley, Ltd., 7 % Cum. Pref., 1 to 9,600 ..	15	10½%	.	...	9 — 11	9 — 11	...	...
12,500	Henley's (W. T.) Telegraph Works, Ltd., Ord.	10	8 %	10 %	12 %	22½ - 23½xd	22½— 23½	23½	22½
8,000	Do. do. do. 7% Pref. ...	10	7 %	7 %	7 %	18½ - 19½xd	18½ — 19½	19	...
20,000	Do. do. do. 4½ Mort. Deb. Stock	Stock	4½%	4½%	4½ %	110 - 115	110 —115	...	...
50,000	India-Rubber, Gutta Percha and Teleg. Works, Ltd.	10	0 %	10 %	10 %	21½ - 22½	21½ - 22½	22⅛	21⅜
300,000	Do. do. do. 4 % 1st Mort. Debs	100		...	...	104 —108	104 —108	...	...
37,500	Liverpool Overhead Railway, Ord.	10	2½%	3½%	3½ %	10½ - 10⅝	10⅝ - 10⅝	...	...
10,000	Do. do. Pref., £10 paid	10	5 %	5 %	5 %	15½— 16½	15½ — 16½	...	...
37,350	Telegraph Constn. and Maintce., Ltd.	12	15 %	15 %	15 %	36 — 39 xd	36 — 39	...	...
150,000	Do. do. do. 5 % Bonds, red. 1899	100	5 %	5 %	5 %	102 —105	02 —105	...	...
540,000/	Waterloo and City Railway, Ord. Stock	100	..	...	...	136 —139	135 — 138	137½	135½

† Quotations on Liverpool Stock Exchange.

‡ Unless otherwise stated all shares are fully paid.

Dividends marked § are for a consisting of the latter part of one year and the first part of the next.

Crompton & Co.—The dividends paid on the ordinary shares (which have not a Stock Exchange quotation), are as follows: 1892—0°/₀§; 1891—7°/₀§ 1890—8°/₀.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

* Birmingham Electric Supply Company, Ordinary £5 (fully paid) 10½.

House-to-House Company, 4½% Debentures of £100, 107—109.

Kensington and Knightsbridge Electric Lighting Company, Limited Ordinary Shares £5 (fully paid) 17—18; 1st Preference Cumulative 6 %, £5 (fully paid), 8½—9. Dividend, 1896, on Ordinary Shares 7 %.

London Electric Supply Corporation, £5 Ordinary, 4—4½.

* T. Parker, Ltd., £10 (fully paid), 14—15.

Yorkshire House-to-House Electricity Company, £5 Ordinary Shares fully paid, 8—8½. Dividend for 1896—6 %.

* From Birmingham Share List.

Bank rate of discount 3 per cent. (October 14th, 1897).

THE NORTHAMPTON INSTITUTE.

This Institute was formally opened last Friday evening by the Lord Mayor and Lady Mayoress, and the Sheriffs. As we have already mentioned, the land upon which the magnificent buildings have been erected, was presented by the late Marquis of Northampton and by his son, the present Marquis. The value of this gift is £25,000, and the erection and equipment of the buildings has cost £80,000. There is to be a further outlay of £10,000, to £15,000 for completing the equipment. The money was provided by the City Parochial Authorities, the Technical Education Board, the City Companies, &c.

The Northampton Institute forms an important branch of the City Polytechnic, and is to supply the neighbourhood in which it stands with the same educational advantages as are afforded by similar institutes to other parts of the metropolis, *i.e.*, the Birkbeck Institute, and the City of London College.

The scheme was originated in 1891, and the full work, both educational and social, started at the end of September, 1897. An idea of the success which has so far attended the Institute, may be gained from the fact that there are already 1,500 members. Mr. Charles Dorman, chairman of the governing body, in explaining matters to the Lord Mayor on Friday, said that they had equipped 17 large workshops, and seven laboratories in addition to numerous social rooms, studios, offices, &c. He remarked that perhaps no other district in the metropolis has such a large number of manufacturing trades as Clerkenwell, and the Institute could not fail to benefit the numerous mechanical, electrical, and artistic trades. The cost of carrying on the work of the Institute is estimated at from £9,000 to £10,000 per annum. Lord Mayor Davies delivered a speech well worthy of the occasion, and among other speakers were Sir Henry Longley, K.C.B., Mr. R. M. Beachcroft, L.C.C., (who, referring to the gifts of the City companies, said that if it were not for those companies we should be 20 years behind in technical education) and Lord Alwyne Compton, M.P., acknowledged the thanks accorded to the Marquis of Northampton.

An inspection of the various departments was afterwards made, while a concert proceeded in the large hall.

Mr. John Ashford, A.M.I.M.E., is the head of the mechanical engineering and metal trades department.

The engineering workshop is equipped on the two long sides with hand benches fitted with various kinds of vices. Down the centre of the room there are the machine tools—comprising, at one end, a Universal milling machine, next to that a large drill and a group of lathes, forming excellent examples of English and foreign designs. Across the other end of the shop are the grinders, consisting of an emery wheel for general work, a Universal tool grinder, and a twist drill grinder. The emery wheel shaft is directly coupled to the driving electric motor, and the shaft driving the other grinders also drives the blower for the smithy in the next room. The whole of the power for the machine tools is derived from three different electric motors, so that only the small amount of shafting connected with the tool in use need be run at any one time.

There is a smithy and carpenters' shop, the machine tools in the woodwork room being driven by an electric motor. They comprise at present a band saw, pattern makers' lathes, and a grindstone, but there is room for further tools.

The boiler house contains two 100-H.P. boilers, one of the Lancashire type, the other a Babcock & Wilcox tubular type. The object in having two such different boilers side by side is that the students may have opportunities of making comparative tests of the different performances of the boilers under different conditions of working, and with different kinds of fuel. The steam piping on the top of the boilers is constructed of welded steel, and has been specially arranged for experimental purposes. It is such that either boiler may be used separately from the other or in conjunction with it. Injectors, as well as a feed pump, are fixed, and the stop valves are of different patterns, so that the students may have opportunities of inspecting and becoming familiar with the various designs in use. The steam raised is used for both heating and power purposes.

The power room for the joint use of the mechanical and electrical departments contains a 100 H.P. Willans and Robinson high-speed engine, coupled directly to a 63-kilowatt dynamo, which is used for lighting the building and for supplying the power to the various workshops and laboratories. From a large switchboard erected at one end of the room 24 circuits can be controlled. Another dynamo has yet to be erected, and this will be driven by a slow speed engine. The power from both dynamos is brought to the switchboard to a couple of omnibus bars, from which it can be delivered to any one of the 24 distributing circuits. In addition, alternating current supply from the central station of the Public Supply Company is brought to another pair of bars on the board, and from these bars any of the 24 circuits can have power given to them. The board contains the usual measuring instruments, switches, &c.

One-half of the instrument workshop is equipped for bench work,

and has benches both for metal and wood work with the ordinary hand tools. The other half contains the power-driven machinery, consisting chiefly of lathes of various patterns, a sensitive drilling machine, polishing spindles, and a grindstone, the whole of the power for these being derived from an electric motor placed in the room.

The largest class that meets in this room is that for electric light wiremen, who are practised in the manipulation of all kinds of electric fittings of the most recent type, and the most modern methods of jointing and insulating the joints by vulcanising and otherwise. In addition there are important classes in electrical instrument making and in the brass finishing, special attention being given in the latter to repetition work.

A special feature of the drawing offices is the system of lighting, which is that of inverted electric arcs. The same system is adopted for the art studio.

Dr. Mullineux Walmsley is the principal of the Institute, and he is head of the applied physics and electrical engineering department, with Mr. C. V. Drysdale as chief assistant and senior lecturer, Mr. E. T. Martin as demonstrator and instructor in instrument making, Mr. K. Edgcumbe as senior demonstrator, Mr. W. R. Elliott as junior demonstrator and assistant mechanic, Mr. A. C. Jolly as lecture assistant, and Messrs Robins and Grew as junior assistants.

In the electrotyping room all the mechanical operations connected with electrotyping are dealt with. The whole process of preparing the moulds for the bath and of mounting and finishing the electrotype after deposition is carried through here, but the actual electrodeposition takes place in a separate room set apart for electrochemistry.

A room is being fitted as a laboratory for metallurgical chemistry, but the equipment is at present incomplete. It is intended, with a metallurgical laboratory, to be ready next session.

The junior physical laboratory is fitted for technical work in applied physics, and during the present session its accommodation has been strained by large classes in electrical engineering, and telegraphy and telephony. It has also been used for physical work in connection with the engineering and building trades sections. The equipment consists of the most recent types of testing instruments and experimental apparatus, and the various experiments performed by the students are of a thoroughly practical character.

In the senior physical laboratory, a good start has been made in the provision of delicate and standard instruments for important technical testing and experiments, but the equipment is not yet nearly completed. The chief work at present carried on in the room is testing in its most advanced branches, in connection with the advanced courses of electrical engineering and telegraphy and telephony.

The heavy electrical engineering laboratory is placed in the basement, and next to the "power room," already described. It is being equipped for the most advanced work in electrical engineering. The power for driving various continuous current dynamos and alternators is supplied by a 6 H.P. electric motor, whose speed can be altered through wide limits. This motor is directly coupled to a Ferranti alternator, and drives other machines by belts. A special feature of the room is, that rails have been sunk in the floor, so that the placing of a new dynamo or motor in position for testing purposes can be accomplished in a very short time. On the window ledges are acid-proof chambers for two small batteries of secondary cells, which will furnish large currents when required for testing instruments. A special table is being fitted up with very complete arrangements for the calibration of commercial electrical measuring instruments.

Next to the senior physical laboratory, a laboratory for electrochemistry is being fitted up. The equipment of the room is not yet complete, but there will be found specially designed tables capable of accommodating 16 students in the subject at one time. There are the usual depositing and cleansing, &c., vats, those giving rise to deleterious fumes and vapours being placed under a large hood, communicating with a shaft in which there is an electrically driven fan for carrying off the noxious gases. A special feature of the room is, that the depositing dynamo is directly coupled to an alternate current motor supplied with power, not from the dynamo room, but from the public mains, thus practically demonstrating to the electroplaters of Clerkenwell a method for utilising the electric mains now laid throughout the district for the purposes of their trade, although the currents directly obtainable from those mains are not suitable for plating work. In addition to the dynamo, there are secondary cells on the window ledges capable of giving large currents for plating purposes when the dynamo is not running, and from these cells conductors will be run alongside the vats, and also to the experimental tables, giving in all parts of the room a ready means of procuring currents suitable for electro-depositing.

THE GAS ENGINE AND ITS MISSION.

In view of the increasing popularity of the gas engine, the *Railroad Gazette* publishes a series of articles under the above head, in which are discussed the points of the gas engine. There are stated to be 100 makers in the United States, one quarter of whom own genuine works exclusively devoted to gas engine business. We need not follow the writer through the history and elementary descriptions.

While the ordinary initial pressures are 250 to 300 lbs. per square inch, the writer has met with compression to 96 lbs. and an initial pressure of 405 lbs., pressures which make a large demand on workmanship. In America, the latest engine is the Westinghouse, with two vertical cylinders in the smaller sizes and three in the larger engines. The latter have, therefore, an impulse every 240° of crank revolution, and are claimed to give a brake horse-power for 13 feet of natural gas. They govern partly by reduced admission and partly by missed explosions.

Governing is a serious difficulty with gas engines. The omission of explosions requires high speeds and very heavy fly-wheels, and demands a margin of speed between upper and lower limits of some breadth. By reducing gas admission the efficiency is so much reduced that while the Belfast engines used 24 feet of Belfast gas under best conditions, the consumption rose to 40 feet for one-quarter load. The compromise system hits somewhere between the two.

American practice in ignition tends to the use of the electric spark as perhaps more convenient if less economical than the ignition tube. For valves, American practice resembles European in its use of the mushroom or similar valve, but tends towards their automatic movement, so abolishing much outside gear and producing a simple looking engine. With automatic valves engines may be run equally well in either direction. There appears also a tendency in America to employ gas engines, not simply in small industries, but in large works for sub-division of power of the kind one looks for with electricity. Small steam engines are very wasteful. Small gas engines are not anything like so wasteful as compared with their larger brethren as are small steam engines. But there is still a radical fault in gas engines. They have no reserve of power beyond their economical rate of working. A gas engine underloaded is wasteful. Its economy improves up to the point where every possible explosive stroke is explosive. When an engine is fully loaded, with steam valve open to the full, it begins to run slow if any further load is put on it and by running slow it increases its mean pressure and decreases its resistance. But, with a gas engine, as with an elephant, every response is made up to the maximum, and beyond this the engine lies down, so to speak, and stops. The gas engine lacks staying power because it lives a mere hand to mouth existence. Between the gas engine which will not run overloaded, and the oil engine which stops if too lightly loaded, the internal combustion engine cannot be held to have reached the forefront of prime movers despite its economy. We do not think so much of the starting difficulty as the author before us. The starting arrangements of large gas engines are various. There is the reservoir of compressed air, the hand pump on similar lines, the explosive cartridge, and various other self starters. We have very little doubt ourselves that the large engines of the future will follow on the lines of the large steam engines and be started by small engines, which themselves can of course be started by a man, as usual with a small gas engine. Messrs. Hartley & Petit do use this system, and applied the little starting engine to the large gas engine for Mr. Arthur Porrit, of Birstall, which they put down to work with the Thwaite gas producer we have already described.

The various difficulties with gas engines have no doubt kept them in the background, even where the conditions have been favourable to the employment of producer gas. Gas producers, however, until lately, have not been successful for powers much under 100 H.P., but they are now on the market as small as 35 H.P., at which size they are about as large and not nearly so dangerous as a 35 H.P. vertical boiler. Statistics for Germany point to one gas engine for each 1,015 inhabitants, and the average power is 3·36 H.P. Engines are increasing at about 9½ per cent. per annum in number, and about 12 per cent. in their average power. The author gives the cost of power for the four prime movers, steam, oil, city-gas engines and producer-gas engines as ¾ cent. per H.P. hour, 1½ cents, 2½ cents, and ¾ cent. Oil in America comes out cheaper than city-gas by a larger amount than it does in England where gas is cheaper and oil is dearer, but producer gas ought to be as cheap in America as anywhere, and we should look to a considerable extension of producer gas plants.

The author holds that the objections he has advanced are not perhaps insurmountable. At the same time they have not yet been surmounted, and they must be grasped and appreciated before the position of gas power can be properly understood. We always have had a good deal of respect ourselves for the Clerk gas engine with its separate pump, and should like to have seen it a success. We think in large installations of gas power that the engines will have an explosion every revolution, that one engine will be set apart pumping up a reservoir of gas and a reservoir of air to flow into the cylinder and push out the exhaust, and that in this or some similar manner engines will do double duty for their size as compared with existing engines. The gas engine is yet far from perfect, but it is slowly improving and it has the very powerful argument of economy to push forward its interests. In the steam engine power is manufactured and stored in the boiler. There is always fire enough to suffice for a very considerable number of revolutions of the engine at full power, apart from other reserves. Besides this store of heat there is a mass of heated water in the boiler ready to give off energy should the demand for steam exceed for a time its production, and there is yet a store of ready made steam in the steam space to fulfil the same end, and when power has been manufactured there is still the fly-wheel to store a portion ready for immediate calls. The steam engine has four items of stored energy. The gas engine has but one, the fly-wheel. It has no mass of partly burned fuel ready to give off heat and to go into a state of more energetic heat production by the opening of a damper. It has no heat stored in water, and no store of elastic vapour. The movement of its governor orders the "stoking" of a fresh charge of fuel, its lighting up, combustion, and steam raising, and in the fraction of a second the fuel is lighted, consumed, the steam it raises is used and discharged, and unless the governor again asks for it, the fire remains out.

A consideration of these facts shows us that in the gas engine there is cut out a considerable duration of time between the shovelling on of fuel and the use of the steam generated by that fuel. This explains at once both the economy and the delicacy of the gas engine. In the economy of nature the food of to-day may appear as muscular energy to-morrow, or it may be later. The animal

machine will run for hours on no fuel at all. It will run for days on less fuel than is represented by the energy produced. The gas engine is like what a horse would be that could not walk 10 yards without a nibble from its nosebag. This is not to argue that the engine is on wrong principles, but that the mechanical difficulties which hem it in are yet only incompletely solved.

THE TELEPHONE SYSTEM IN LONDON.

Conference of Local Authorities

On Thursday afternoon of last week a well-attended conference of local authorities, convened by the City Corporation, was held at the Guildhall, to discuss the question of the telephone system of London.

The Lord Mayor, in opening the proceedings, said he did not intend to take any part in the proceedings, for it was a subject he did not really understand, but he welcomed the local bodies outside the City to the Guildhall.

After some preliminaries, Mr. A. C. Morton was elected to the chair, and said that was a conference of delegates representing the vestries and local boards of the metropolis, convened by the Corporation with the object of ascertaining the views of the local governing bodies in London as to the cost and efficiency of the London telephone service. Thirty-one boards and vestries, out of 41, as well as the City Corporation, had signified their intention of sending delegates, and 25 of these bodies had intimated that they had applied to the Treasury for an inquiry into the cost and efficiency of the telephone service in London, and all matters relating thereto. They were aware of the action taken by the late Commission of Sewers with a view to obtaining a cheaper and more efficient service. The late Commission, in 1895, after having ascertained the views of the telephone subscribers in the City, gave evidence before the Select Committee of the House of Commons, which inquired into the matter last year, but in consequence of the dissolution of Parliament the Committee had not sufficient time to report, and they recommended that another committee should be appointed in the next session to consider and report on the evidence already taken, and, if necessary, to take further evidence. No action had, however, been taken. Having referred to the recent action before the Railway Commissioners between the Corporation and the Post Office, the chairman said that the opinion of the Corporation was that the roads and streets in the metropolis belong to the people, and that they ought not to be given up to any trading company, unless under conditions which would protect the public. The Lord Mayor had handed him a letter which he had received, and that he would ask the Town Clerk to read.

Sir John Monckton then read a letter which the Lord Mayor had received from the National Telephone Company. This communication, which was signed by Mr. J. S. Forbes, as president of the company, began with an expression of doubt that the announcement of the conference could be correct. If it should prove that it had been made on good authority, it seemed to the company that what was to be done was like inverting the natural order of things. But probably the real meaning was that the resolutions were only to be put when the conference had before it some reliable evidence. In any case it was clear that the company was to be treated as defendants in a suit, and it would only be fair that they should be heard in the preliminary inquiries, and before being, so to speak, committed for trial. As president of the company, and in the interest of all concerned in the conference and its results, he desired to tender some points which he thought might be usefully borne in mind in any discussion on the subject. His colleagues and himself would be the first to admit that the telephone service as at present conducted left much to be desired, not for want of will on the part of the company, but for want of those reasonable facilities at the hands of the local authorities, without which it was absolutely impossible to conduct the business with the highest efficiency. It was singular that in this matter London, generally so advanced, should lag behind Manchester, Leeds, and many of the other large cities and towns, in which the companies had succeeded by agreement with the authorities in securing upon moderate and reasonable terms the necessary use of the streets for underground cables and wires, to the immense advantage of the users of the telephone, owing to the improvement in promptness and efficiency which had immediately followed. It was true that in a few cases such powers had been granted in disconnected portions of London. But apart from this, the company's network of wires, accommodating close upon 17,500 subscribers, existed upon sufferance, and was subject to constant interference and interruption by persons who, from caprice or other motives, inflicted heavy loss upon the company, and serious interference with the subscribers. Under such a condition of things, a perfect telephonic system was impossible. The letter went on to say that the recent inquiry held in Glasgow, raised points identical with those sought to be raised in London. That inquiry lasted 11 days, the cost to the company was over £4,000, to the Corporation it was over £3,000, and to a combination of would-be promoters of a competing system, nobody knew how much. They did not yet know what the report of the commissioner was, but it might be worth while to wait until his report was before entering upon another precisely similar inquiry. Having frankly admitted the present shortcomings of the service, Mr. Forbes desired to say something on the subject of charge, and in doing so, he would deal with the year 1897. The London area covered 609 square miles, and the number of subscribers at the end of the year, was 17,371. The average subscription was £14 10s., equal to about 5s. 7d. per week, day and night, including Sundays. It had been computed by the general manager that during the year there were 30,000,000 calls, involving as many answers, or 60,000,000 conversations, each averaging 200 words. Each conversation cost the subscriber about 1d. When it was taken into account that the company had to pay about 10 per cent. on its gross receipts for exchange business to Government, and was subject to heavy charges for wayleaves, he thought the charge of 1d. a message was very small. Comparing this with the cost of Post Office telegrams, he found that the 73,000,000 messages sent—the total for the United Kingdom—averaged 7½d., representing only 15 words. In conclusion, Mr. Forbes said if the conference thought it expedient to appoint a committee as a preliminary to further action, the company would be ready to place at their service all evidence and information that their experience enabled them to offer.

The Chairman: I am bound to say that the answer to that letter is in the second resolution.

The letter was then laid on the table.

Mr. Robinson (Kensington) moved: "That in the opinion of this conference of delegates representing the Corporation of London and the vestries and local boards in the metropolis, the present telephone service of London is both inadequate, inefficient, and costly." The position before them was that the Treasury had laid down that if the service was inadequate or inefficient it would grant an inquiry, and as they were agreed that it was inadequate and inefficient, they had a perfect right to ask for an inquiry.

Mr. Matthew (Stoke Newington) seconded the motion.

Mr. Trenner (Holborn) said that Mr. Forbes frankly admitted that the service was unsatisfactory, and so he had practically pleaded guilty, and should have no objection to being sent to trial. There were many complaints as to the lines; they were told the lines were engaged, and he asked whether they thought the line was always engaged, or whether it was merely a flippant answer on the part of the girls managing the telephone.

The motion was carried.

Mr. Pankhurst (Marylebone) then moved that: "In the opinion of this conference an inquiry should be held by the Treasury as to the cost and efficiency of the London telephone service, and all matters relating thereto, agreeably to the request of the local authorities of London." He had had a painful experience of the telephone. His business brought him into relationship with Glasgow and Manchester, and other places, and he was told the charge was only £8 in some places. It was all very well for Mr. Forbes to try and hoodwink them that the average cost was only £14 10s., but the average business man paid £20 a year, and that was quite as much as he should be expected to pay. He certainly thought they should have a service for £10 in London.

Mr. Savory (Stoke Newington) seconded the motion, and referred to the time the company took to connect a new subscriber.

Mr. Trenner called attention to the fact that two years ago on the occasion of the great storm, the service completely broke down, but although many subscribers could not use their wires for two, and even three months, no reduction was made in the subscription.

Mr. C. W. Tagg (Camberwell) said that having passed the first resolution, he did not see why they should not adopt No. 2. If they were all to give their experience of the National Telephone Company, and the language they had used, he thought it would be preferable to put the question at once. The only people who could hold a proper inquiry into the matter was the Treasury, and any person who wanted to give evidence could do so before them.

Mr. Alderman Smallman observed that while the Corporation threw blame on the National Telephone Company, Mr. Forbes threw all the blame on the local authorities, and it was therefore better to have an inquiry by the Treasury.

Mr. Knight (Limehouse) thought it would be well for the company to arrange at once not only with the City of London but with the whole of the metropolitan boards and vestries for the right of way under the streets, and the difficulty would then be ended at once.

Mr. Kimber (Wandsworth) asked whether it would not be well to suggest some remedy for the existing state of things.

The Chairman: I think the words "all matters relating thereto" covers everything.

Mr. Kimber: Very well. I am satisfied.

Mr. Kebshaw (Shoreditch) said he would have liked to have heard something about the average charge of £14 10s. How that was done was by bringing in the private house charge of £10.

Mr. Paton (Limehouse) said he had been a customer of the company from the commencement, and having paid at first £20, he now paid £17. He thought the Telephone Company were fools in their own interest for not paying the vestries to allow them to lay underground wires. If they lowered the charge to about half they would get double the number of customers, and the cost of working would be little extra.

Mr. Haskell (Hammersmith) said that the company allowed local lines of £10, but they could not speak to the City.

Mr. Valentine (Poplar) gave the result of some correspondence with the company which his board had had. The company only wanted to pay a few pounds for laying the wires underground, and consequently the board would not allow them to do so.

Mr. Waycott (Paddington) said there was a much wider question as to whether the telephone should be municipalised. He thought the resolution should be amended, somewhat in that spirit, whether it should not be municipalised either by the London County Council or by the vestries.

Mr. Richardson (Hampstead) rose to a point of order. He took it that the question raised by the speaker was not within the scope of the conference.

The Chairman: The question, in my opinion, is entirely outside the scope of the conference.

Mr. Waycott rose to speak again, but met with considerable interruption, and refused to speak further.

The Chairman said they wanted a much larger inquiry in London than in Glasgow. It might cost a little more money, but it was the

only way out of the difficulty. The Corporation had never played the dog in the manger policy. They had said: "You can have our streets on terms and conditions which favour the public."

The resolution was then carried.

Mr. Dewey (Islington) said what had impressed him was that that conference had not been so much a conference of delegates of local authorities as of customers of the National Company. Every gentleman seemed to attempt to use his powers as a trustee for the public, to enable him to get some private advantage by means of the telephone. He said, unhesitatingly, that if the National Telephone Company had no statutory powers, the local authority had no power to grant easement. He said that was knowledge of 30 years of the Metropolitan Management Act. The local authorities had the powers of surveyors of highways over the streets, and nothing more. He thought the company should get statutory powers, and then the local bodies could have the power of purchase after a fixed number of years. He moved—"That, inasmuch as the National Telephone Company is not possessed of statutory powers for placing mains, pipes, or wires underneath the streets of the metropolis, the road authorities have no legal right to permit the user of the streets for such a purpose, and that it is undesirable they should profess to give such permission until the interests of the public are duly secured by statute, as in the case of tramways and electric lighting undertakings."

Mr. Giles (Greenwich) seconded the motion.

Alderman Smallman moved as an amendment:—"That, inasmuch as the National Telephone Company is not possessed of statutory powers for placing mains, pipes, or wires underneath the streets of the metropolis, it is undesirable that the local authorities should give such permission until the interests of the public are duly secured by statute, as in the case of tramways and electric lighting undertakings, and subject always to the previous consent of the road authorities."

Col. Probyn (Strand) seconded the amendment.

Mr. Tapp (Fulham) observed that suburban parishes were worse off for telephonic communication than small villages in New Zealand.

Mr. Tagg said it was simply a waste of time to discuss the question whether the local authorities had power to allow the Telephone Company to take up the streets, for if the company had no power, the Post Office had.

The amendment was carried.

It was agreed that copies of the resolutions be forwarded to the Treasury, the Corporation of London, the London County Council, and the vestries and local boards of the metropolis.

Mr. Paton moved a vote of thanks to the Corporation of London for calling the conference, and the proceedings closed.

THE NORTHERN SOCIETY OF ELECTRICAL ENGINEERS.

The Practical Operation of Multiphase Currents. By T. Hawkins, Member. March 14th, 1898.

An electrical transmission of power plant may be divided into three main sections, viz., generators, motors, and line. In describing or inspecting such a plant, one naturally starts at the power house.

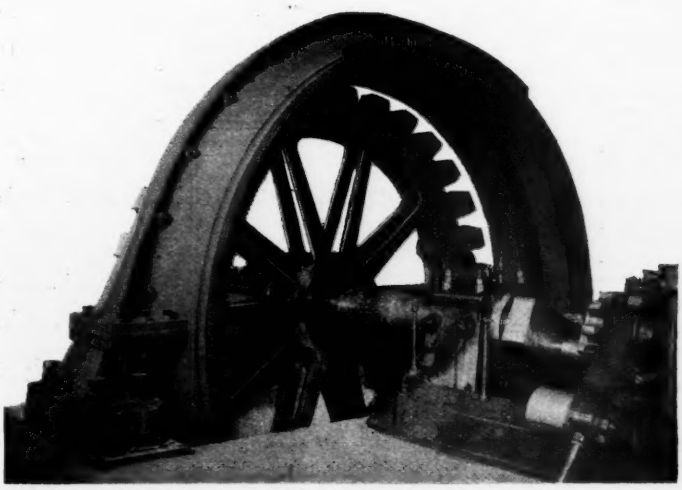


Fig. 1.—1,000-H.P. 3-Phase Generator Constructed by Oerlikon Company.

A multiphase generator is an alternating current dynamo, having its armature conductors grouped in such a manner as to give over a two-phase system two distinct currents differing 90° in phase. A three-phase generator would have its armature conductors arranged to give three currents differing 60° in phase.

For power plants where the distance between the generator and the various motors is not too great, and permits of a low pressure system being used (say 200 volts), a generator with a revolving armature makes a cheap and efficient type of machine. Where, however, the electromotive force exceeds 500 volts, it is better to have the armature stationary, which allows of increased facilities for securing and maintaining the insulation necessary for high voltages. In this case the field magnet is made to revolve, and the exciting coil or coils need not have a difference of potential exceeding 100 volts, even for very large machines.

The generators in use for the different plants described in this paper are of the "Inductor" type. This is undoubtedly a more mechanical piece of machinery than either of the foregoing. Its distinguishing features are that all windings are stationary, being fixed securely to the main frame, and that there are no brushes or sliding contacts whatever, the only revolving part of the machine being the iron or steel inductor. The armature consists of two laminated iron rings, enclosed by a cast-steel frame. This frame serves both as a support and as a magnetic path between the two laminated rings.

As will be seen from fig. 1, sufficient space is left between the two laminated rings for the insertion of the single exciting coil. The armature conductors are embedded in holes close to the inner circumference of the laminated rings. To prevent eddy currents, the pole pieces of the inductor are made up of laminated iron strips.

A multiphase induction motor has two distinct electrical circuits, viz., the primary and the secondary. The primary circuit, when supplied with multiphase currents, produces a rotary magnetic field. The action of this rotating field is to induce in the secondary circuit currents of low potential. It is the reaction between the rotating magnetic field and the induced currents in the secondary, which sets up a torque giving the required rotation. Either the primary or secondary can be designed to revolve.

If the primary circuit were made to revolve it would be necessary to fit it with sliding contacts, so as to connect it electrically with the feeding circuit.

One advantage attained by this method is, that it allows of easy insertion of a starting resistance into the circuit of the secondary; but as there is no difficulty experienced in inserting a resistance in a rotating secondary, if required, it is better to fix the primary and dispense with the sliding contacts. The stationary element is generally spoken of as the stator, and the revolving element as the rotor.

It is now the usual practice to have the primary or inducing circuit stationary, and to allow the secondary to revolve, so as to take advantage of the very low potential at which the currents are induced in the secondary circuit; also, because the circuit in this part is enclosed on itself, and is independent of the feeding circuit.

Small motors up to 8 or 10 H.P. are switched into circuit directly from the mains by means of an ordinary three-pole switch without the use of any resistances; but for larger machines, it is advisable to use starting resistances, either in the stator or rotor circuit, otherwise excessive current will be taken from the mains.

For large motors, not requiring to start against a heavy load, starting resistances can be used in the stator circuit. These resistances may be of two kinds: either inductive, known as automatic transformers, or non-inductive, which may be either liquid or metallic.

The maximum torque of a motor having a permanently short-circuited rotor, *i.e.*, a rotor which is not connected to an outside resistance is obtained when its full electromotive force is across the stator. If, however, the motor is not called upon to develop its maximum torque, a lower torque can be obtained by reducing the electromotive force across the stator terminals to such a point as will give the necessary strength of field for the required torque, the object of this being to reduce the starting current to a minimum and still enable the motor to get away.

The auto. transformer is of simple construction, and is similar to the "economy coil" used in alternating current arc lamps for obtaining a reduced voltage across the arc.

As an example, we will suppose the motor is designed to work on a 200-volt circuit; the transformer is divided into four parts, giving 200, 175, 150, and 100 volts. The motor may be connected to any one of these four voltages. We will assume it gives the required torque at 150 volts; a throw-over switch is required, one side of which is permanently connected across the 150 volts, and the other side across the maximum voltage of the circuit. To start up, the switch is put on the 150-volt side, and when the machine has attained its normal speed, it is thrown over to the 200-volts side, the automatic transformer being at the same time thrown out of circuit.

If a liquid resistance is used, it is made sufficiently large to prevent a sudden rush of current when the circuit is closed. The plates are then lowered into the liquid until there is sufficient electromotive force across the stator to start the machine. When the machine has attained its proper speed, this resistance is entirely cut out.

If it is necessary that the motor shall develop its maximum torque at starting, it is obtained by inserting a resistance in the rotor circuit. See fig. 2.

A starting resistance of this description is necessary, for the following reason:—When primary current is switched on, the rotary is, of course, at rest, and the lines of the rotating field are cutting the

rotor conductors at a maximum rate, thereby inducing very large currents in the rotor, which has a very low resistance. These reduced currents in turn re-act on the stator field, and weaken it.

To obtain the greatest torque, we must keep up the strength of the stator field, and this is got by introducing resistances into the rotor circuit. Of course, the result of introducing the external resistance

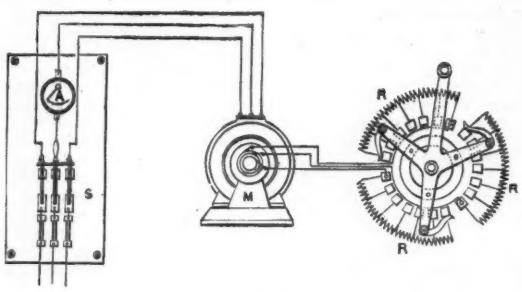


Fig. 2.

is to check the currents in the rotor, and so prevent them from unduly overpowering the stator field.

There is a certain resistance which allows the exact amount of current in the rotor to obtain maximum starting torque. The starting resistance should, however, be designed with resistance in excess of this, so as to prevent too great a current in the line when closing the circuit.

This variable resistance is connected in the rotor circuit in a three-phase motor, through three slide rings; the winding of the rotor and of the resistance box being in three circuits. This resistance is gradually switched out while the machine is running up to its normal speed. When this speed is attained, the resistance is short circuited and the three brushes lifted. The motor is now running quite free, without any sliding contacts or resistances; and for all constant-speed machinery these slide rings are only used for starting up.

I think I am right in stating that there is a much larger demand for constant-speed motors than for motors with a variable speed. It certainly is more economical to run the machines at the speed at which they are designed to give their maximum efficiency, and obtain, if possible, the variations by mechanical methods. Of course, this cannot always be done.

I have described to you the three ways which are commonly used for starting up multiphase motors. Motors up to 10 H.P. to be merely switched into circuit without resistance; motors of larger sizes requiring to give, say, twice their normal running torque at starting, to be switched in with the resistance in stator; and motors above 10 H.P., requiring to develop their maximum torque, to be fitted with sliding contacts, these sliding contacts to be used for starting purposes only.

Now, in a power plant calling for an aggregate of, say, 300 H.P. in motors, it is likely that only a small number would be required to develop their maximum torque, and these could be supplied with a starting arrangement and slide rings.

We can suppose there are 20 motors below 10 H.P. absorbing a total of 130 H.P., four motors of 15 H.P. with automatic transformers, two motors of 30 H.P., and one motor of 50 H.P., with slide rings, making in all 27 motors, three of which would be fitted with slide rings.

Here is a fairly large installation, requiring only three starting boxes amongst 27 motors, 24 having no sliding contacts whatever, and three having sliding contacts in use for starting purposes only.

If this were a continuous current installation, there would be, to begin with, 27 boxes; and to compare the motors, there would be 27 commutators, and about 150 carbon brushes and brush-holders.

The stator we may consider as corresponding to the field magnet of a continuous current motor. Both can be made reliable, and, as a rule, give little or no trouble. But it is to the merits of the rotor I particularly wish to call your attention. It is minus the commutator, brushes, and intricate brush work, and instead of taking the full potential of the circuit it has a difference of potential of only a few volts.

It is simply a laminated cylinder, with holes round its periphery, in which are placed solid rectangular bars connected at either end by a copper or brass casting, as per fig. 3.

The only part which has any insulation at all is the conductor, which has a light covering of tape, and this is only put on to confine the induced currents to the copper. This insulation gives a slightly increased efficiency, but should it fail the motor will still work, as the bars are already purposely short-circuited at certain points to the iron supports of the rotor.

Fig. 3 shows a rotor in which these bars are bolted directly to the end rings; no solder is used. The bolts have split spring washers under the nuts to allow of expansion and contraction of the metal, and still keep good contact. I may say that this particular rotor is one constructed by the Westinghouse Company.

You will notice, too, that there is no need for any binding wires or string. Not only is this part of the machine simplicity itself, but we have dispensed with comparatively high voltages, and as the machine is commutatorless and brushless, we can, once and for all, dismiss from our minds any anxiety as to sparking, even with sudden overloads, as sparking cannot occur unless the circuit of the primary or secondary is forcibly broken. The only limit to output is the heating of the stator on continuous overload. Wear and tear is reduced to the friction of the bearings, and as long as these get their proper supply of oil, the machine requires no other attention.

As an example, the multiphase motors at the General Electric Company's works, at Manchester, are only inspected once a month, and then only for the purpose of supplying fresh oil, if necessary.

The constant speed multiphase motor is a good regulator. Between no load and full load for an average size machine, the variation of speed is about 4 per cent.

The speed at which the motor runs depends upon the speed of the rotating field, and the speed of the rotating field is controlled by the number of the stator poles and the frequency which is being used in the installation.

At this point it would be as well to state that one cannot lay down a general law as to what frequency is best. As a rule, for motor work, it is not more than 60 cycles. The frequency is one of the two

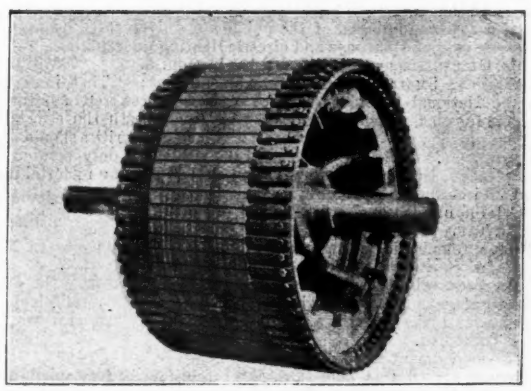


Fig. 3.

factors which control the speed, and it depends in a great measure on the class of machinery which is to be driven as to what is the best frequency to adopt. One would be inclined to keep it as high as possible, so as to keep down the weight, and therefore the price of the machine, as the speed varies directly as the frequency.

For instance, a motor giving 10 H.P. at 60 cycles and 1,150 revolutions per minute, would, at 60 cycles, run at 575 revolutions per minute, and give only 5 H.P.

The other way of decreasing the speed of the motor is to increase the number of stator poles; but this is not usually done, as to have too large a number of poles means great leakage, and, as a rule, the motors are, in the first place, designed with the maximum number of poles compatible with high efficiency.

I have stated that the multiphase generator need have no rotating windings at all; the only rotating part being a steel or iron casting. This reduces the attention and upkeep to a minimum, and I may here state that some installations which have been running in this country for two years, have, as yet, required no repairs whatever, and are practically as good to-day as the day they were put in.

(*To be continued.*)

THE RELATIVE IMPORTANCE OF CENTRAL STATION LOSSES.

A few sentences on the above subject are to be found among the editorials of the *Electrical World* of New York, dated January 29th. They point out in a brief and lucid manner what often escapes attention, namely, the relative importance of loss at the lamp terminals, for instance, as compared to the loss in the boiler room.

Bad firing or loss of heat by the chimney simply represents a waste of fireman's wages and coal. Then are traced the losses due to condensation in steam pipes and cylinders, which involve in addition to these increased boiler capacity to supply them; in turn, the losses in dynamos, mains, fittings, &c., are followed, each involving a corresponding increase of plant, until the lamps are arrived at.

It is not only astonishing but positively alarming, when one fully realises that the loss in efficiency in the lamps requires a proportional increase in boilers, engines, generators, mains, transformers, feeders, as well as wages for attendance, and also augment the losses in every part of the system where increased load means increased loss. Our con-

temporary's remarks end here, but we think they could have been carried much farther. In addition to all the above, we have to provide increased capital expenditure in plant, buildings, and mains, increased rates, rents and taxes, increased depreciation, repairs, reserve and maintenance.

The gentlemen who spend their time in securing every customer in every town where electricity works are established, and who often flourish certain letters on their cards which should guarantee their technical abilities, would do well to remember these facts. They should be most useful to the seller of a really good high efficiency lamp, and it would be worth his trouble to demonstrate to the engineer in charge of the electricity works in the towns he visits the truth of his assertions. We have generally understood from the gentlemen referred to, that their lamps were of the highest efficiency in the market, and a halfpenny cheaper than any other, and the halfpenny cheaper often sells the lamp.

It would afford an instructive evening's entertainment to many central station engineers to quietly think over what it means to them; the better and more efficient the lamps connected to his system the greater number he can supply with a given plant.

When he recollects how many tight squeezes he has had to "get over the peak," he will, perhaps, appreciate what it would have done for him had all his lamps been of the highest efficiency.

The generation and distribution of electricity has been reduced to a science, and it is unfortunate, in one sense, that the suppliers of electricity have no control of that part of their system most remote from the generating mediums where losses tell most heavily in proportion, namely, in the consumers' lamps. It follows that two towns similarly situated as to coal, water, and class of consumer with plants identical, may from the fact that bad and inefficient lamps are used in one case and high efficiency lamps are used in the other show totally different results, and the true reason never be suspected. Little continuous wastes mount up to large sums when added up at the end of a year. We have known cases where the stopping of several small leakages at joints in the steam pipes has resulted in an appreciable lowering of the coal consumption; while the covering of the front of a boiler with non-conducting material and the stoppage of leaky glands have had the same effect.

True, these gains were small, but they were continuous and in time told up. Although the loss due to inefficiency in an incandescent lamp is small, yet it is taking place all the time the lamp is burning, and the number of lamps connected to the system being necessarily large, these infinitesimal losses soon mount up to a respectable amount, and begin to make themselves felt.

The losses in every step of the transformation process, from the latent chemical energy of the fuel to the light emitted from the lamps have been well thought out, and means taken to reduce them as much as possible; there are losses, however, which come under other heads, and the rectifying of which does not come under the control of the engineering staff, or we think they would be soon non-existent.

We refer to an item which might well come under the heading of wastes, for it no doubt influences, perhaps unconsciously, the efficiency of the whole system. We refer to the frequent changes taking place in the engineering staff. The man who puts coal on the fires, and the man who oils the bearings, are well paid for their labours; the policy being to get the best skilled labour in these departments, and to make the men contented with their posts, and thereby provide against their leaving.

Look a little higher up, and what do we find? Men who have spent years, and perhaps much money, to gain the experience necessary to enable them to fulfil the many and varied duties called for, and on whom the responsibility of the working and management of a most expensive plant, in many cases running into six figures, receiving wages, for we can scarcely call it salary, about equal to a foreman in a foundry, or a shopwalker in a draper's shop. We repudiate the idea that insufficient remuneration affects the performance of duty, yet we cannot help thinking the many changes we see week by week of engineers leaving one town to go to another when a slight increase of salary is attached cannot but have a detrimental effect on the economy of the system. In many cases we see men drifting right away into other channels where their experience commands more remuneration.

It surely holds good that if a skilled workman is to be made contented with his job and his services permanently secured, he must be suitably paid. The engineers should have a like consideration extended to them, and until this is done we feel sure that there will always be present a waste which has only one cure.

The man who has to give up social life, practically, if he does his duty, and devotes the whole of his time and attention to the duties of his office, cannot possibly do it complete justice if his mind is constantly occupied with the economical working of his household plant, if the term may be used.

ELECTRICAL DRIVING

Mr. Raworth continues the correspondence in *Engineering* anent electrical driving, and assures Mr. Hirschmann, of whose letter we have already spoken, that 85 per cent. efficiency between indicated and electrical H.P. is not overstated, and claims that electrical engineers have ample proof that this can be attained and surpassed. He gives examples. A Holmes dynamo and Willans engine of 200 H.P. tested, by Prof. Kennedy, showed 85·7 per cent. in 1893. A Belliss-Crompton set of 200 H.P. at St. Pancras, tested by Prof. Robinson, gave 88·5 per cent. A Universal engine driving a Mordey alternator, was tested recently by Messrs. Kincaid, Waller & Manville to show 88 per cent., and included the power to drive air pump and exciter. Mr. Raworth points out that he allowed 65 electrical horse-power to produce 60 mechanical horse-power, so that he allowed 7½ per cent. loss on transmission and conversion at the motor—a narrow margin, it is true, but not too small if motor making is taken up with serious spirit. English made motors are, however, far too costly to permit of favourable comparisons with line shafts on the score of first cost, but American motors are now less than half the price of English motors of two or three years back, and great improvements may be looked for in this direction.

Mr. Raworth wants to make a national saving of 30 per cent. in fuel, and he does not doubt even the cotton spinner being able to see a profit and an advantage in ridding himself of belts, and of tall smoky chimneys. He suggests that electrical engineers may sit still if they choose, and watch the development abroad and in America, but he throws doubts upon the cordiality of the greeting of our grandfathers in the dim hereafter. This is very funny—"the dread of something after death," is to stir us now to "enterprises of great pith and moment." Three cheers for our grandfathers. But seriously, electrical engineers, and, indeed, all other engineers may wisely take Mr. Raworth in all seriousness. The cheapness of gas in this country has been a commercial set-back to the electric light industry, the excellence of our common roads has been against tramways of any kind, and not merely a bar to electrical progress. Moreover, the vested interests are so great in a settled old country, that it is difficult to get schemes taken up. We venture to say that, if new ventures in America demanded the same amount of preliminary energy to get them into shape that is required in old countries, the progress would be as slow as it is here, and Englishmen have not been idle even if they have not much to show. At the same time there is no harm done in reminding them that effort must be great and persistent. The mechanical work can be done if only it can be got to do. The difficulties are those incidental to any old-established country in which there are alternative methods. People who prate so very much of the American progress in electrical traction have failed to note that America has no common roads as we understand them. There may be cart tracks here and there, but the country is too new and too vast to have built a system of good roads.

For the American post office to carry on a parcel post by horse traction on the common roads, as is done here, would not be possible. Comparatively speaking, America has a

very small mileage of railroads, and obviously the electric line has a larger and freer field for its growth than we have with our closer network of steam railroads as well as common roads.

But there are fields to be tilled abroad—in India and in China. In the latter country there must be a gradual leavening of returned Coinamen from California and Australia who are ready to ride on a car, and are in a position to expound matters to the stay-at-homes. China as a market ought to be preserved, or where are our engineering financiers to find play for their energies in the near future, before Africa is better developed?

NEW PATENTS AND ABSTRACTS OF PUBLISHED SPECIFICATIONS.

NEW PATENTS.—1898.

[Compiled expressly for this journal by W. P. Thompson & Co., *Electrical Patent Agents, 322, High Holborn, London, W.C., to whom all inquiries should be addressed.]*

5,501. "Improved apparatus for regulating the pressure on electric mains chiefly in connection with storage batteries." J. S. Highfield. Dated March 7th.

5,533. "Improvements in electric high and low tension fuse-heads for blasting purposes." W. A. Malson and S. R. Malson. Dated March 7th.

5,544. "An electric fog-signalling apparatus." J. Woods. Dated March 7th.

5,550. "Improvements in and connected with dynamo electric machinery." M. T. Pickstone, R. S. Portheim, and A. C. Peebles. Dated March 7th. (*Complete.*)

5,560. "An improved holder for carbon and other brushes for electric motors, dynamos, and the like." A. L. Armstrong. Dated March 7th.

5,571. "Improvements in or connected with the application of electricity to marine propulsion." W. T. Carter, John A. Dawson, and T. Gray. Dated March 7th.

5,584. "Improvements in switches for electric glow lamps." A. B. Kistritz. Dated March 7th.

5,590. "Improvements in microphones." A. H. Skold. Dated March 7th.

5,596. "Improvements in electric arc lamps." S. Bergmann. Dated March 7th.

5,644. "Improvements in electric lamps for photographic and similar purposes." W. C. Cubbin and G. E. Johnston. Dated March 8th.

5,663. "Improvements in metallic conductors for protecting electric wires and cables." P. C. Middleton and F. Huggins. Dated March 8th.

5,672. "An improved electrical safety lamp for miners." H. H. Lake. (O. Siedentopf, Germany.) Dated March 8th. (*Complete.*)

5,680. "Improvements in telephone speaking tube and like receivers." H. A. Cutmore. Dated March 8th.

5,686. "Improvements in and relating to dynamo-electric machines and electro-motors." S. G. Brown. Dated March 8th.

5,693. "Innovation in electric lighters (pyrophore)." W. von Zabern. Dated March 8th.

5,703. "Improvements in electrodes for secondary batteries or accumulators." H. Pieper Fils. Dated March 8th.

5,704. "Improvements in electrodes for secondary batteries or accumulators." H. Pieper Fils. Dated March 8th.

5,705. "Improvements in the manufacture and production of electrodes for secondary batteries." H. Pieper Fils. Dated March 8th.

5,729. "Improved apparatus for the electric ignition in internal combustion engines." R. A. Miles. Dated March 9th.

5,750. "An improved form of automatic transformer switch." J. E. M. Stewart. Dated March 9th.

5,783. "Improvements in electric tram and railway systems." W. C. C. Hawtayne. Dated March 9th.

5,806. "Improvements in the manufacture of metal bases for electric incandescence lamps." H. H. Lake. (La Compagnie General des Lampes a Incandescence, France.) Dated March 9th. (*Complete.*)

5,810. "Process for making an electrical conductor and an insulating body of tar asphalt and the like materials." W. P. Thompson. (A. Lessing, Germany.) Dated March 9th.

5,823. "Improvements in and in connection with underground conduit electric railways." E. Heyl-Dia. Dated March 9th.

5,830. "Improvements in and in connection with incandescent electric lamps." E. Heyl-Dia. Dated March 9th.

5,863. "Improvements in incandescent electric lights and in processes therefor." W. L. Voelker. Dated March 10th. (*Complete.*)

5,912. "Improvements in electrical galvanic batteries." G. Laura. Dated March 10th. (*Complete.*)

5,934. "Improvements in conduits for electric conductors." J. J. Bate. Dated March 10th. (*Complete.*)

5,950. "Improvements in or connected with the application of electromotors to propulsion." W. T. Carter, J. A. Dawson, and T. Gray. Dated March 10th.

5,959. "Improvements in guards for flames or fragile objects, such as incandescence lamps, glass globes, &c." H. N. Moody and A. L. Davis. Dated March 11th.

6,014. "The springless contacts bayonet holder for electric incandescent lamps." L. Bertgues. Dated March 11th.

6,022. "Improvements in primary, voltaic, or galvanic batteries." P. Lafargue and E. Droulт. Dated March 11th.

6,024. "Improvements in and relating to conduits for electric cables." W. Sykes. Dated March 11th.

6,025. "Improvements in and relating to draw and junction boxes for electric mains." W. Sykes. Dated March 11th.

6,026. "An electric drill." R. J. Crowley and C. H. Preston. Dated March 11th.

6,028. "Improvements in the method of and apparatus for the electro-deposition of metals." J. Holloway. Dated March 11th.

6,032. "Improvements in electrical or electro-magnetic therapeutic apparatus." O. Waratka and E. Sachs. Dated March 11th.

6,039. "Improved apparatus for electro-plating and polishing various small articles." A. E. Honey. Dated March 11th.

6,044. "Improvements in secondary batteries." A. Werner. Dated March 11th.

6,049. "Improvements in electrical measuring and indicating apparatus." A. U. Alcock. Dated March 11th.

6,058. "Apparatus for transmitting motion to a distance by means of electrical energy." Siemens Bros. & Co., Ltd. (Siemens and Halske, Aktien Gesellschaft, Germany.) Dated March 11th.

6,108. "Movement mechanism for electric apparatuses." P. Richter and T. Weil. Dated March 12th.

6,109. "Improved electric arc lamps." P. Richter and T. Weil. Dated March 12th.

6,110. "Improvements in blades for electric current collectors." P. Richter and T. Weil. Dated March 12th.

6,135. "Improvements in electric incandescence lamps." W. Nernst. Dated March 12th.

6,145. "Process for hardening and rendering tenacious the active mass of electric accumulators." R. von Barby. Dated March 12th. (*Complete.*)

ABSTRACTS OF PUBLISHED SPECIFICATIONS.

Copies of any of these Specifications may be obtained of Messrs. W. P. Thompson & Co., 322, High Holborn, W.C., *price, post free, 9d. (in stamps).]*

1897.

16,579. "Process of electro-glazing tile sections to form a plate for windows and the like." J. M. Ewen. Dated September 4th, 1897. This relates to electrolytic processes and devices applied particularly to securing tile sections of prismatic glass in the metallic frames intended therefor. In mounting prismatic glass sections, to form an entire sheet of glass for a window, such sections are arranged in a frame-like construction of thin metallic strips, which is immersed in an electrolytic bath. The current being applied, there will be an electro deposit along the metallic strips and between them and the glass sections, until finally a complete frame is formed and the glass or tile sections are secured together in one sheet. As frames and window openings are usually of great size, it is necessary to have a solution of very great depth in the tank; compressed air is forced through lead pipes at the bottom of the tank, which keeps the solution a uniform density, and thus stops all tendency towards irregular deposits on the foundation cathode skeleton frame between the lenses. 3 claims.

16,629. "Improvements relating to conduits for electric conductors." H. E. Newton. (The American Silesc Company, of 39-41, Cortlandt Street, New York.) Dated September 4th, 1897. This relates to improvements in conduits for electrical purposes with the object of providing a metallic race-way for the reception of either bare or insulated wires. The race-ways are constructed and the conductor may be drawn through them and consist of a suitable metal which is capable of being bent without breaking. They are made in lengths to correspond to the sections of a conduit in which they are located. They are packed at suitable distances apart from one another and from the interior wall of the conduit by means of powdered silesc; it being found that pure silesc has no tendency to absorb moisture, is a non-conductor of heat and is at the same time a perfect non-conductor of electricity. Wads of mica are provided at the ends of the adjacent sections of conduits and are snugly fitted around the race-ways and between the race-ways of the interior walls of the conduit, and provided with corresponding receding and projecting portions at the adjacent ends of the race-ways, for the purpose of breaking joint and to cause the adjacent faces of the wads to impinge against each other when the ends of the conduit sections are forced together. To connect these sections of conduit their ends are screwed on the outside and they are joined by a coupling nut. 5 claims.